The Dictyotales (Algae: Phaeophyta) of New South Wales

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A survey is given of the Dictyotales (Phaeophyta) on the New South Wales mainland coast. Twenty-two species are recognized in 13 genera: *Dictyopteris*, *Dictyota*, *Dilophus*, *Distromium*, *Homoeostrichus*, *Lobophora*, *Lobospira*, *Pachydictyon*, *Padina*, *Spatoglossum*, *Stypopodium*, *Taonia*, and *Zonaria*. For each, a concise description with illustrations, based on New South Wales material, is presented. Keys are provided to genera and species.

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INTRODUCTION

Brown algae in the Order Dictyotales Kjellman are a conspicuous component of the lower eulittoral and sublittoral marine flora of the New South Wales coast (King and Farrant, 1987). Many specimens, especially immature plants, of the Dictyotales on the New South Wales coast have been difficult to identify despite publications from southern Queensland (Cribb, 1954), southern Australia (Womersley, 1967, 1987) and Lord Howe Island, New South Wales (31°33′S, 159°05′E) (Allender and Kraft, 1983). Lord Howe Island is administratively part of New South Wales, but it is as far removed from the mainland New South Wales coast as are much of Queensland and Victoria (Fig. 1).

The Dictyotales is a distinctive order and members can be recognized by a flattened thallus with apical growth, tufts of surface hairs and oogamous reproduction with characteristic antheridia and oogonia on or embedded in the thallus surface (Womersley, 1987). The plants are usually erect or occasionally decumbent in habit. The fronds are either dichotomous, subdichotomous or irregular if growth is initiated by a single apical cell or a small group of apical cells, or flabellate or irregular if growth is from a row of marginal cells.

The Dictyotales have been placed traditionally in a single family, the Dictyotaceae, within which two tribes were recognized: the Dictyoteae, characterized by a single apical cell, and the Zonarieae with a group or marginal row of apical cells. Womersley (1987) notes that two families, the Dictyotaceae and the Zonariaceae, may seem warranted, but that their recognition is not satisfactory for some juvenile stages. There are two genera which, though clearly members of the Dictyotales, are sufficiently distinct to warrant placement in separate families. Allender (1980) placed the genus *Dictyotopsis* Troll in a new family, Dictyotopsidaceae. In this family the single apical cell segments laterally and the thallus is monostromatic. In those members of the Dictyotaceae which possess a single apical cell it is oriented transversely to the branch apex or is conical and new cells are cut off only from the lower side (Womersley, 1987). *Dictyotopsis*, represented by the single species *D. propagulifera* Troll, has not been found on New South Wales shores though sterile plants have been recorded by one of us (R.J.K.) associated with mangroves in Queensland (near the mouth of the Endeavour River and at Hinchinbrook Island). Womersley (1987) has described a new family, the Scoresbyellaceae, for the distinctive monotypic genus *Scoresbyella*. The plants resemble those in the Dictyoteae, but

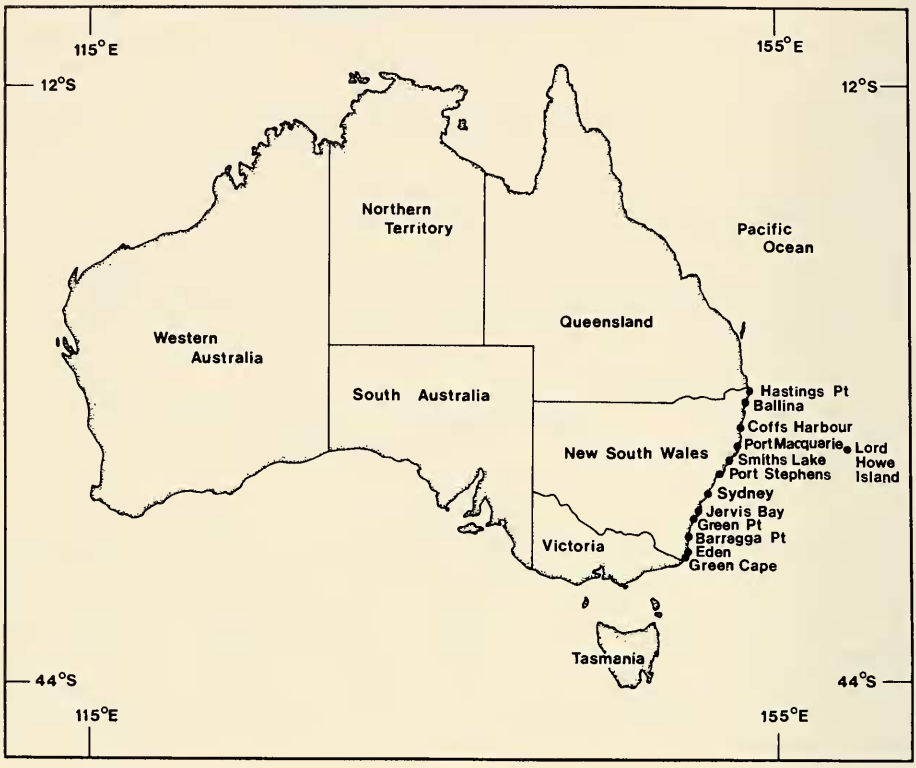


Fig. 1. Locality map.

the apical cell is oriented longitudinally and cells are cut off laterally from two faces rather than from one basal side. *Scoresbyella profunda* Womersley appears to be a rare alga and is thus far known from only a few deep-water collections in South Australia.

The total number of genera in the order Dictyotales is 18 and there are approximately 100 species. All genera except *Stoechospermum* have been recorded in Australia. Fifteen genera and 41 species occur on temperate southern Australian coasts (Womersley, 1987). This contrasts with the generalization that the order is best developed on tropical and subtropical coasts (Haupt, 1932; Bold and Wynne, 1985). Table 1 shows the number of genera and species in various regions of Australia and indicates that the order Dictyotales is well represented in both northern and southern Australia. The high figure for southern Australia reflects the richness of the well-documented algal flora (Womersley, 1981, 1987). The comparable figure for northern Australia is based upon species records only (not including those for Lord Howe Island) (Lewis, 1985), and may be artificially high, especially for *Dictyota*. Of the 44 species recorded in northern Australia, approximately 24 are recorded for Queensland and Norfolk Island, a number similar to that for southern Queensland (20), New South Wales (22), and Lord Howe Island (22).

Materials and Methods

Members of the Order Dictyotales were collected on a regular basis at Fairlight in Sydney Harbour (33°50′S, 151°15′E) in an associated study of the phenology of

TABLE 1

Number of species in the Order Dictyotales recorded for various regions of Australia: northern Australia (after Lewis, 1985), southern Queensland (after Lewis, 1985; Cribb, 1954; N.S.W. herbarium specimens), Lord Howe Island (Allender and Kraft, 1983), New South Wales (this study) and southern Australia (Womersley, 1987)

	nthn Aust.	sthn Qld	Lord Howe Island	N.S.W.	sthn Aust.
ORDER DICTYOTALES					
F. DICTYOTACEAE					
Dictyoteae					
Dictyota	15	6	3	3	7
Dilophus	3	2	2	2	7
Glossophora	2	0	0	0	1
Pachydictyon	0	0	1	1	2
Zonarieae					
Chlanidophora	0	0	0	0	1
Dictyopteris	7	3	5	1	5
Distromium	0	0	1	1	2
Homoeostrichus	0	0	0	2	3
Lobophora	1	1	1	1	1
Lobospira	0	0	0	1	1
Padina	6	6	4	4	4
Spatoglossum	3	1	1	1	1
Stypopodium	3	0	2	1	0
Taonia	1	0	1	1	1
Zonaria	2	1	1	3	4
F. DICTYOTOPSIDACEAE					
Dictyotopsis	1	0	0	0	0
F. SCORESBYELLACEAE					
Scoresbyella	0	0	0	0	1
Total Genera: 17 Species:	44	20	22	22	41

members of the order (King and Farrant, 1987). In addition, collections were made at other localities in New South Wales, but the majority of collections made were from the Sydney region. Localities in the Sydney metropolitan area include Camp Cove, Dobroyd, Fairlight, Lady Jane Beach, Mrs Macquarie's Point, Point Piper and Vaucluse in Sydney Harbour; Bare Island in Botany Bay; Church Point in Pittwater; and Boat Harbour, Clovelly, Collaroy, Fairy Bower, Harbord, Long Bay, Long Reef and Newport on the nearby open coast. Localities in the Jervis Bay area include Plantation Point (inside the bay), Crookhaven Heads (north of the bay) and Steamers Beach (south of the bay). All New South Wales localities other than these can be found in the Reader's Digest Atlas of Australia (1977) or in Fig. 1. Voucher specimens (herbarium sheets and wet material) are lodged in the John T. Waterhouse Herbarium, University of New South Wales (UNSW). Herbarium material from NSW (including the A. H. S. Lucas collection), UNSW, MELU, and selected specimens from MEL and MUCV were examined during the course of the study.

RESULTS

The order Dictyotales in New South Wales is represented by 22 species in 13 genera (Table 2). A key to the genera is presented below and this is followed by a description of each species **based on mature specimens from the New South Wales coast**. Where a

genus is represented by more than one species, a key to the species is given. The descriptions are concise and do not repeat detailed information and complete lists of synonymy readily available elsewhere (especially in Allender and Kraft, 1983; and Womersley, 1987). Rather they concentrate on information necessary for the identification of the taxa. Only where a species has been widely referred to by another name is the synonym given. Seasonality, seasonal and spatial variation in abundance, and seasonal variation in fertility for some of the common species are given by King and Farrant (1987).

TABLE 2

Species of Dictyotales in New South Wales

Dictyopteris acrostichoides (J. Agardh) Boergesen
Dictyota alternifida J. Agardh
Dictyota bartayresii Lamouroux
Dictyota dichotoma (Hudson) Lamouroux
Dilophus intermedius (Zanardini) Allender and Kraft
Dilophus marginatus J. Agardh
Distromium flabellatum Womersley
Homoeostrichus olsenii Womersley
Homoeostrichus sinclairii (Hooker and Harvey) J. Agardh
Lobophora variegata (Lamouroux) Womersley
Lobospira bicuspidata Areschoug
Pachydictyon paniculatum (J. Agardh) J. Agardh
Padina australis Hauck
Padina crassa Yamada
Padina fraseri (Greville) Greville
Padina tenuis Bory
Spatoglossum macrodontum J. Agardh
Stypopodium flabelliforme Weber-van Bosse
Taonia australasica J. Agardh
Zonaria angustata (Kuetzing) Papenfuss
Zonaria crenata J. Agardh
Zonaria diesingiana J. Agardh

The most abundant species, in terms of cover and biomass, in the Sydney area is *Zonaria diesingiana*. Some species are apparently rare (*Padina australis*) or rare but nonetheless widely distributed in New South Wales (*Zonaria crenata*). Other species have more restricted distributions in southern New South Wales (*Lobospira bicuspidata*, *Pachydictyon paniculatum*, *Zonaria angustata*) though they are otherwise more widely distributed in southern Australia. Some collections made in the course of this study were new records, e.g. *Homoeostrichus olsenii* (reported in Womersley, 1987) and *Distromium flabellatum*. Three genera are present in southern Australia but absent from New South Wales: *Scoresbyella*, *Chlanidophora* and *Glossophora*. The record of *Glossophora nigricans* from Plantation Point, New South Wales (May and Larkum, 1981) is of *Dilophus intermedius*. Only one genus, *Stypopodium*, is present in New South Wales but absent on the southern Australian coast. Only two genera (*Homoeostrichus* and *Lobospira*), occur on the New South Wales mainland coast but not at Lord Howe Island, but all the genera at Lord Howe Island are found on the mainland coast.

KEY TO THE DICTYOTALES IN NEW SOUTH WALES

1. Growth initiated by a single apical cell 2
1.* Growth initiated from a marginal row or cluster of apical cells 4
2. Thallus with a single cortical layer and a single medullary layer throughout ..... *Dictyota*

2.* Thallus with more than one layer of either cortical cells or medullary cells, at least along margins 3
3. Medulla single-layered, cortex two or more cells thick in older thallus parts, at least at the margins ..... *Pachydictyon*
3.* Medulla two or more cells thick, at least at the margins, cortex single-layered throughout ..... *Dilophus*
4. Meristem a localized cluster of apical cells 5
4.* Meristem of terminal row of apical cells 7
5. Thallus with thickened terete axis and slender flat branches with ultimate divisions spirally twisted and bicuspidate ..... *Lobospira*
5.* Thallus flattened throughout 6
6. Frond with a prominent midrib ..... *Dictyopteris*
6.* Frond without a prominent midrib ..... *Spatoglossum*
7. Apical margin of the thallus inrolled ..... *Padina*
7.* Apical margin of the thallus not inrolled 8
8. Thallus two cells thick throughout ..... *Distromium*
8.* Thallus more than two cells thick, at least in mature parts 9
9. Medullary cells rectangular and in regular tiers in transverse section 10
9.* Medullary cells neither uniformly rectangular nor in regular tiers in transverse section 12
10. Central medullary cells distinctly larger than other medullary cells in transverse section ..... *Lobophora*
10.* Medullary cells of similar size throughout transverse section 11
11. Generally paired cortical cells to each medullary cell, sporangia producing eight aplanospores ..... *Zonaria*
11.* Generally single cortical cell to each medullary cell, sporangia producing four aplanospores ..... *Homoeostrichus*
12. Pronounced size differentiation between smaller pigmented cortical cells and larger colourless medullary cells, distal fronds thick, becoming 4 cells thick several cells below the apex ..... *Stypopodium*
12.* No pronounced difference in size between pigmented cortical cells and colourless medullary cells, distal fronds thin, remaining 2 cells thick for some distance below the apex ..... *Taonia*

Dictyota Lamouroux

Growth initiated by a single relatively large apical cell. **Thalli** complanate, membranous; fronds with dichotomous or partly pseudo-alternate branching; hair tufts not associated with reproductive organs; in section a single layer of large medullary cells and a single layered cortex of small pigmented cells.

There are three species of *Dictyota* on the New South Wales coast, *D. alternifida*, *D. bartayresii* and *D. dichotoma*.

KEY TO THE SPECIES OF *DICTYOTA* IN NEW SOUTH WALES

1. Fronds broad at the apices, tapering towards the base ..... *D. bartayresii*
1.* Fronds linear, or tapering slightly towards the apex 2
2. Fronds narrow, generally about 1 mm wide (range 0.5-4mm [2-4mm wide forms have 2-4cm long internodes and the thallus tends to spiral]) ..... *D. alternifida*
2.* Fronds broad, generally greater than 4 mm wide (range 2-14mm [2-4mm forms have internodes shorter than 2cm and the thallus does not tend to spiral]) ..... *D. dichotoma*

Dictyota alternifida J. Agardh, 1894:80. Womersley, 1987: 198.

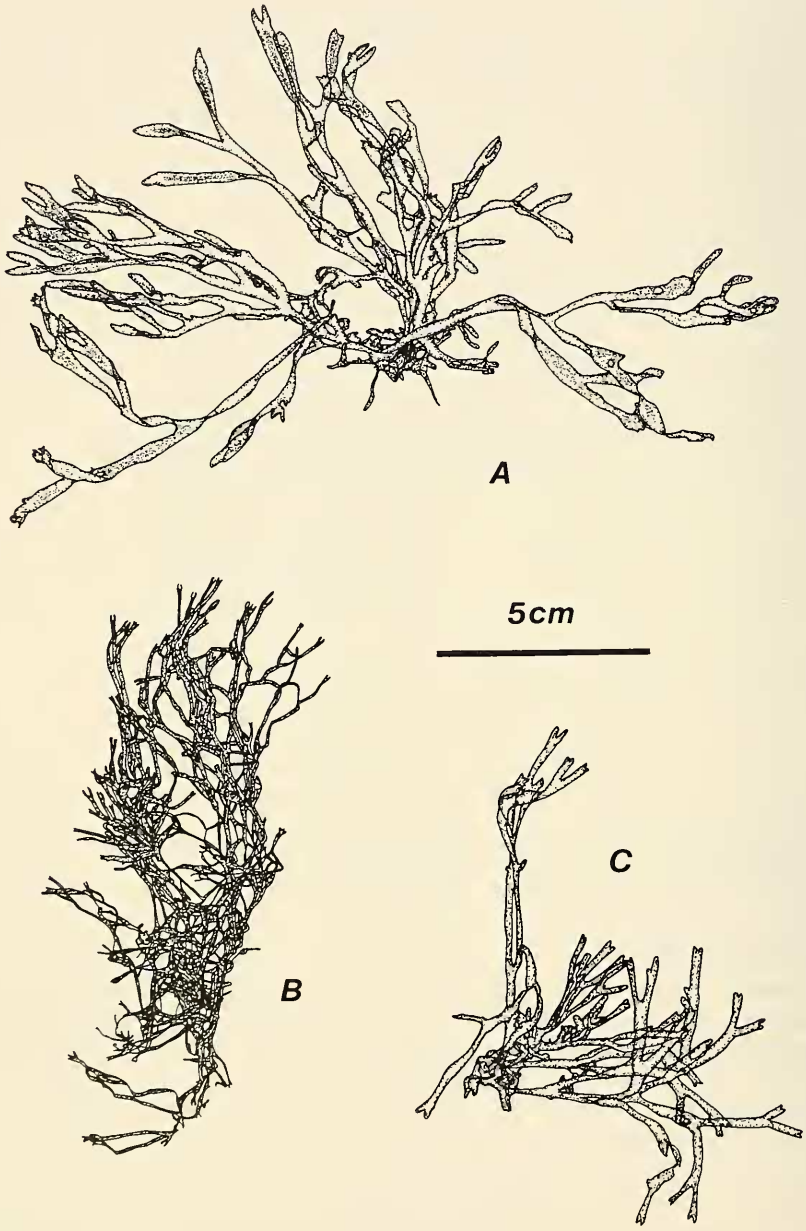


Fig. 2. Dictyota alternifida: (**A**) habit of broad-fronded open coast form, slightly spiralled (UNSW 17605a), (**B**), habit of fine form (UNSW 18050), and (**C**) usual habit (UNSW 17779).

Thalli (5-)7-10(-14)cm long; fronds 0.5-2(-4)mm wide (Fig. 2**A-C**), linear, sometimes twisted, tapering slightly toward the tip, apices usually acute, margins smooth to undulate (occasionally with proliferations); branching dichotomous at 0.5-1.5(-4)cm

intervals, with a narrow branching angle (less than 90°, usually 45° or less); sporangia scattered (Fig. 2A).

Plants from rough-water localities have wider fronds (to 4mm), but are distinguished from *Dictyota dichotoma* by their longer internodes (2-4cm) and the tendency of the thallus to spiral (Fig. 2A). Such plants form a continuous series with more typical *D. alternifida* specimens and can be readily distinguished from *D. dichotoma* in the field. The wide variation in this species and the relationship to other 'narrow' species requires detailed study. Plants referred to *D. alternifida* from New South Wales coastal saline lagoons display unusual thallus variations including frond proliferations, distal crowding of branches, recurved branching angles, apiculate branch ends and spiralling. One unusual specimen from the Coffs Harbour region (UNSW 18605) is here referred to *D. alternifida*, although this may prove to be a different species should more specimens become available.

Seasonality: collected in all months; sporangial plants in all months except January; no sexual material found.

Australian distribution: not previously recorded for New South Wales, although Lucas (1909) recorded the species for northern and southern Australia; the most common species of *Dictyota* in southern Australia (Womersley, 1987); found right along the New South Wales coast in a range of habitats, from shallow sandy sublittoral areas on rough water coasts to positions of extreme shelter in coastal saline lagoons.

Selected specimens examined: New South Wales: Hastings Point, 19-v-1986, *Phillips*, MUCV 2562; Coffs Harbour, 2-4m, 4-x-1981, *Farrant*, UNSW 18050; Hat Head, LWM, 9-x-1985, *P. and W. Farrant*, UNSW 18643; Smiths Lake, 23-iv-1984, *King*, UNSW 16204; Long Reef, 10-vii-1975, *Harada* R2101, NSW; Fairy Bower, 2-3m, 1-xii-1985, *Farrant*, UNSW 18594; Dobroyd, 10m, 24-ix-1985, *Farrant*, UNSW 18530; Clovelly, 1-3m, 28-ii-1985, *Farrant*, UNSW 17659. South Australia: Cape Northumberland (38°03′S, 140°40′E), 15-x-1985, *Womersley*, NSW ex ADU A56812.

Womersley (1987) has noted that species concepts in the genus *Dictyota* are not well established and that the degree of variation in many species is considerable. *Dictyota linearis* J. Agardh and *D. dichotoma* var. *intricata* [both recorded for New South Wales by May (1939)] are here placed under *D. alternifida*. *Dictyota linearis* is characterized by narrow twisted fronds. The majority of the plants from New South Wales do not show this feature, although many fit the description of the species given by Earle (1969) (who nonetheless questions the validity of this species). *Dictyota furcellata* (C. Agardh) J. Agardh was recorded by May *et al.* (1978) and by Borowitzka *et al.* (1982) for New South Wales. All specimens on which these records were based are considered to be *D. alternifida*. We have also placed under *D. alternifida* all narrow forms, including those from coastal saline lagoons.

Dictyota bartayresii Lamouroux, 1809:331. Cribb, 1954:20; Allender and Kraft, 1983:112.

Thalli 5-10cm long; fronds 4-5mm wide at the apices, tapering to 2mm or less at the base; branching sub-dichotomous, dichotomies frequently developing unevenly, branching angle usually 70-90° (Fig. 3A-C); sporangia with involucral cells.

Dictyota bartayresii plants in New South Wales exhibit broad obtuse apices and narrow bases as noted by Cribb (1954). The species is extremely variable (Cribb, 1954) and Allender and Kraft (1983) placed plants from Lord Howe Island (which taper to the apices as well as the base) into this taxon. The well-developed striations reported by Allender and Kraft (1983) and seen in some Queensland specimens (e.g. UNSW 15354) are not seen in New South Wales plants.

Seasonality: may be seasonal in New South Wales since most plants collected in the period September-November; only one sporangial plant examined (NSW: *V. May* 1045, Collaroy).

Australian distribution: pantropical, including south-eastern Queensland (Cribb, 1954) and Lord Howe Island (Allender and Kraft, 1983); now recorded for New South Wales, on rocks, 5-15m deep.

Selected specimens examined: New South Wales: Broughton I., 15m, 28-iv-1985, *Farrant*, UNSW 18017; Collaroy, drift, 16-xi-1945, *V. May* 1045, NSW; Long Reef, 15m, 16-xi-1985, *Farrant*, UNSW 18575; Fairlight, 2-3m, 16-ix-1985, *Farrant*, UNSW 18511; Dobroyd, 10m, 24-ix-1985, *Farrant*, UNSW 18531; Clovelly, 27-viii-1987, *D. May*, MUCV 2576; Bare I., 10m, 17-x-1985, *Farrant*, UNSW 18564; Plantation Point, 1-x-1974, *Larkum and May*, NSW.

Dictyota dichotoma (Hudson) Lamouroux, 1809:331. Womersley, 1987:194.

Thalli 3-20cm long, often with a blue-green irridescence *in situ*; fronds 5-10 (-14)mm wide, linear, tapering slightly towards broad apices, without proliferations; branching dichotomous, branching angle 15-45° (Fig. 4**A-D**); sporangia (Fig. 4**E**) scattered, often densely, over both frond surfaces but frequently in broad transverse bands (Fig. 4**A**), best seen in plants *in situ*; sexual plants dioecious, oogonia (Fig. 4**B**,**F**) and antheridia (Fig. 4**C**,**G**) in scattered sori; male plants often recognizable from the more or less circular 'patches' surrounded by involucral cells which remain after the antheridia have been released.

Seasonality: fertile plants year-round; sporangial plants in every month except May; gametangial plants in all but May, August and November (King and Farrant, 1987).

Australian distribution: widely distributed (Womersley, 1967), with numerous records for New South Wales (Gepp and Gepp, 1906; Lucas, 1909, 1914; May, 1939; Cribb, 1954; May *et al.*, 1970); present in bays, estuaries and on rough water coasts at depths to 16m, on rock or other substrata, often epiphytic.

Selected specimens examined: New South Wales: NW Solitary I., 10-16m, 6-x-1985, *Farrant*, UNSW 18613; Coffs Harbour, 28-viii-1980, *Millar*, MELU AM 362; Port Macquarie, 0-2m, 10-x-1985, *P. and W. Farrant*, UNSW 18658; Newport, 21-x-1944, *V. May* 422, NSW; Clovelly, 2-3m, 10-iv-1985, *Farrant and Puttock*, UNSW 17760; Botany Bay, Jan. 1905, *Lucas*, NSW 140397; Bare I., 1-2m, 13-iii-1985, *Farrant and Puttock*, UNSW 17692; Kiama, 20-xi-1945, *V. May 1062*, NSW; Crookhaven Heads, 30-iv-1977, *King and Kertesz*, UNSW 15347.

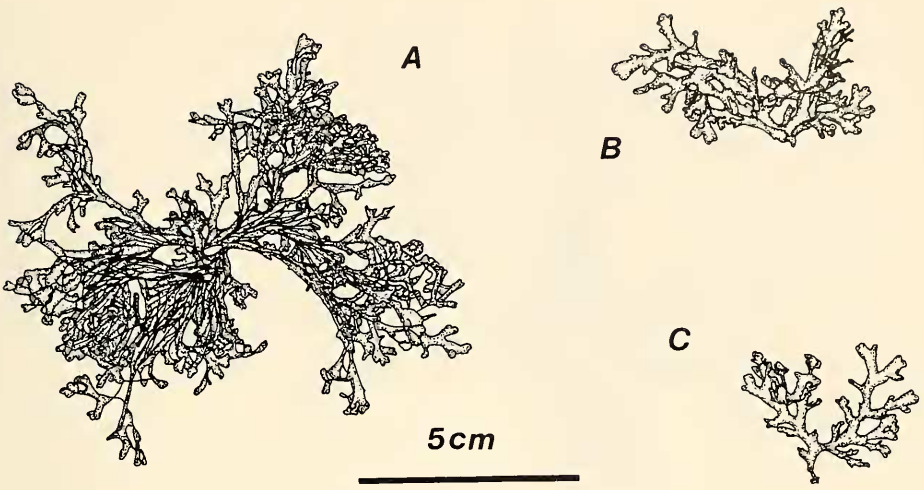
The New South Wales records of *Dictyota papenfussii* Lindauer (Lindauer *et al.*, 1961) and of *D. radicans* Harvey (May, 1939) are here referred to *D. dichotoma*.

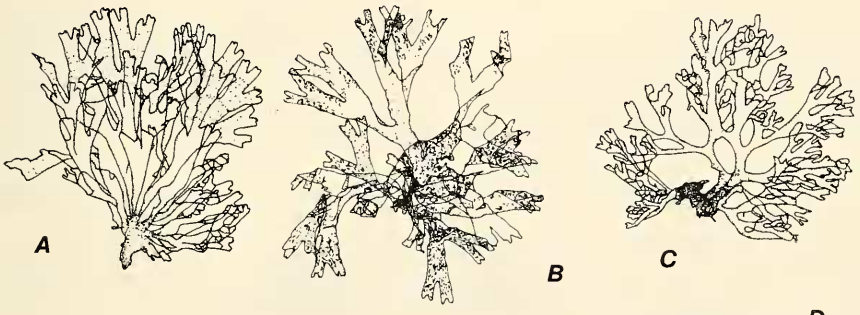
Pachydictyon J. Agardh

Growth initiated by a single protruding apical cell. **Thalli** dichotomous, developing axes which bear alternate lateral branch systems; branches compressed (Womersley, 1987); in section consisting of a single-celled medulla, and a multilayered cortex in older, lower axes.

Pachydictyon paniculatum (J. Agardh) J. Agardh 1894:84. Womersley 1987:211.

Thalli 6-10cm long, attached by numerous flattened slender outgrowths from near the base; fronds 0.5-1mm wide in upper parts, lower parts 2-3mm wide; upper branches fastigiate, subdichotomous to lateral (Fig. 5**A**,**B**); hair tufts and sporangia scattered.





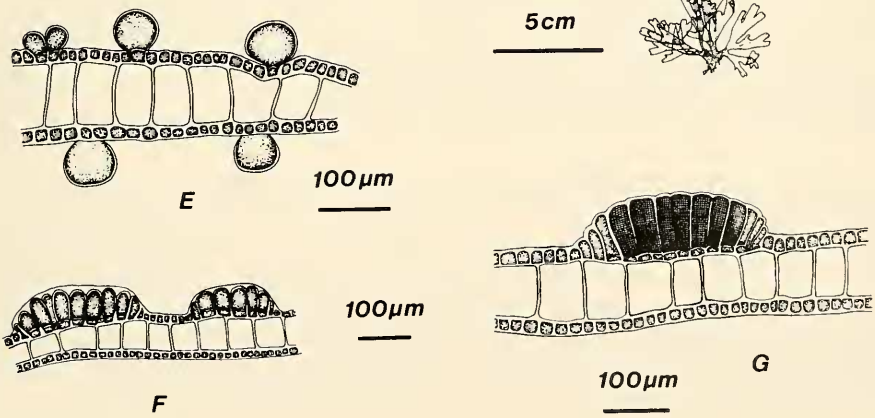


Fig. 3 (above). *Dictyota bartayresii*: (**A**) habit of large plant (UNSW 18554), (**B**) and (**C**) habit of small plants (UNSW 18511).

Fig. 4 (below). *Dictyota dichotoma*: (**A**) habit of sporangial plant (UNSW 18259), (**B**) habit of female plant (UNSW 18069), (**C**) habit of male plant (UNSW 17748), (**D**) small plant (UNSW 17677), (**E**) T.S. sporangial plant (UNSW 18259), (**F**) T.S. female plant (UNSW 18069), and (**G**) T.S. male plant (UNSW 18038, wet material only).

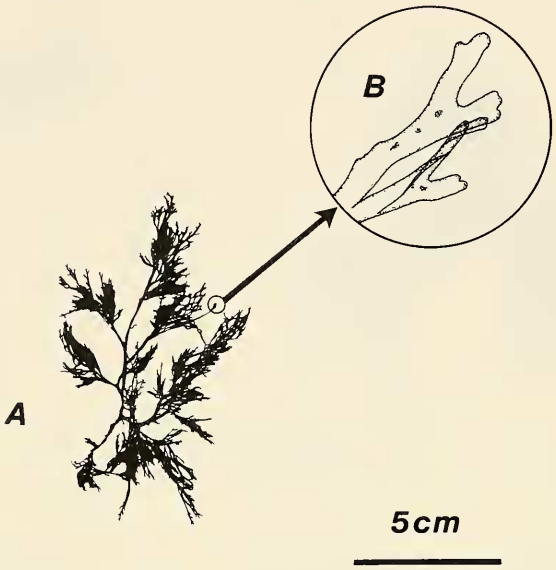


Fig. 5. Pachydictyon paniculatum: (**A**) habit (V. May 2040, NSW), (**B**) frond apex.

New South Wales specimens are smaller than those described from more extensive collections in southern Australia.

Seasonality: early collections made in January (1943, 1946); however no specimens collected in this study.

Australian distribution: in New South Wales appears to be confined to the south coast where it is rare; earlier reports of the species extending as far north as Sydney (e.g. Borowitzka *et al.*, 1982) probably based upon two specimens of *Dictyota* in NSW collected by Lucas and incorrectly identified; in southern Australia epiphytic on larger algae in the upper subtidal under moderate to strong water movement (Womersley, 1987).

Selected specimens examined: New South Wales: Moruya, 7-i-1943, *V. May* 985, NSW; Ulladulla, 13-i-1946, *V. May* 2040, NSW; Green Cape, 1970, *Ducker and King*, MELU 20694. Victoria: Flinders, 5-i-1976, *King*, UNSW 16049.

COMPARISON WITH *PACHYDICTYON* SPECIES IN ADJACENT REGIONS

A second species, *Pachydictyon polycladum* (Kuetzing) Womersley, occurs from Champion Bay, Western Australia to Port Phillip Bay, Victoria (Womersley, 1987), but has not been recorded in New South Wales. A third species of *Pachydictyon* has been recorded for Lord Howe Island. This species, *P. aegerrime* Allender and Kraft, just qualifying as a *Pachydictyon* because on its multicellular cortex, was described on the basis of a single plant, indistinguishable in the field from *Dictyota bartayresii* but lacking horizontal banding, spiralling and involucre cells (Allender and Kraft, 1983).

Dilophus J. Agardh

Growth from a single apical cell. **Thalli** erect, complanate, dichotomously branched or with irregular lateral branching; fronds in section exhibiting a single-celled cortex and a single-celled medulla which becomes multilayered at least at the margins.

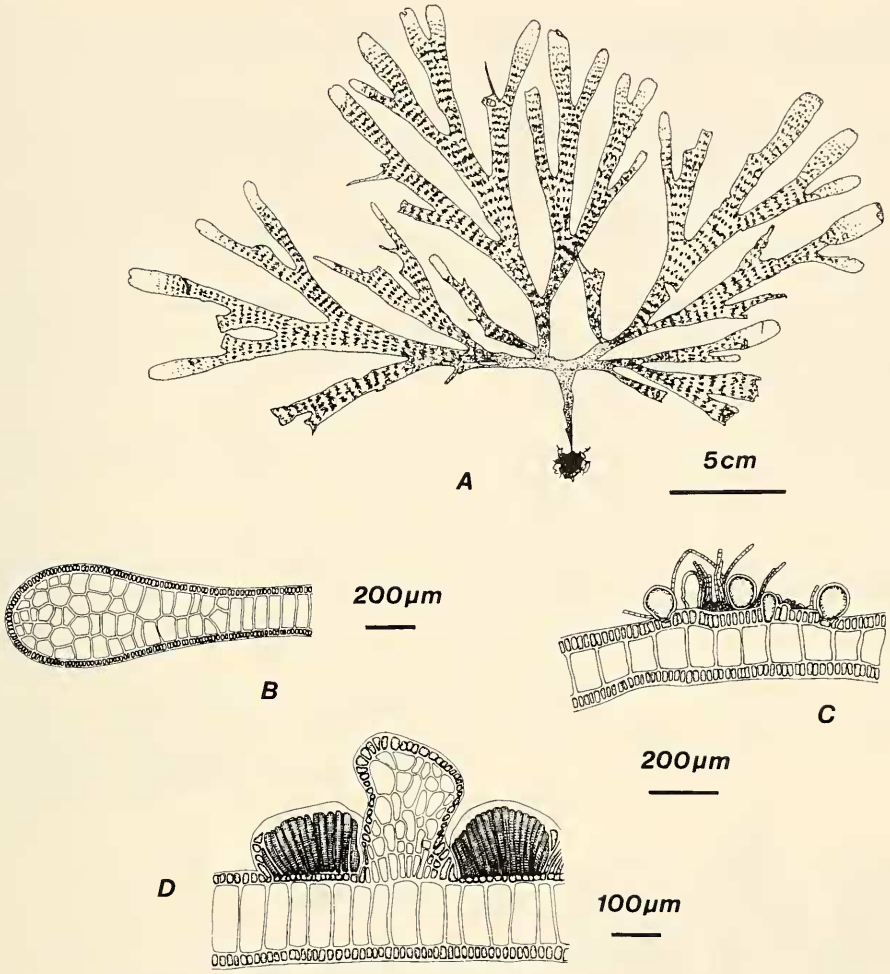


Fig. 6. Dilophus intermedius: (**A**) habit of sporangial plant (UNSW 13789), (**B**) T.S. frond margin (UNSW 18602), (**C**) sporangia (UNSW 17708), (**D**) male gametangia (UNSW 18338).

Two species of *Dilophus* are common on the New South Wales coast: *D. intermedius* and *D. marginatus*.

KEY TO THE SPECIES OF *DILOPHUS* IN NEW SOUTH WALES

1. Mature fronds with branches more than 6mm (usually about 10mm) wide, sori in block-like patches, branches often with abundant flattened proliferations, branches not corrugated ..... *D. intermedius*

1*. Mature fronds with branches less than 6mm wide, sori scattered, not in block-like patches, branches without proliferations, branches corrugated .... *D. marginatus*

Dilophus intermedius (Zanardini) Allender and Kraft, 1983:118.

Thalli 10-40cm long, attached by wiry stolons (Fig. 6**A**); branches 8-13mm (usually about 10mm) wide, often bearing proliferations up to 10mm long in rows across lower

frond surfaces; in transverse section medulla 1(-2) cells thick, up to 4-6 cells thick at the margins (Fig. 6**B**); sporangia (Fig. 6**C**) in block-like patterns on the frond surface (Fig. 6**A**); antheridia in indusiate sori (Fig. 6**D**).

The species is apparently very variable (Allender and Kraft, 1983: fig. 25) and we include the collection from Long Reef (MELU GK6921, duplicate in UNSW) within this species. Plants in this collection are dark brown, with diffuse sori rather than block-like sori, and proliferations along the margins which may be consequent on damage.

Seasonality: sporangial plants collected in March, April, May, June and October; male plants found in March and April, the first record of gametangial plants of *Dilophus intermedius*.

Australian distribution: Lord Howe Island, and the mainland coast from Sydney north to Queensland (Allender and Kraft, 1983; Cribb, 1954; Lindauer *et al.* 1961; May, 1939; Gepp and Gepp, 1906); in this survey as far south as Jervis Bay, growing on rocks in the upper sublittoral.

Selected specimens examined: New South Wales: Hastings Point, 19-v-1986, *Phillips*, MUCV 2558; Split Solitary I., 16m, 5-x-1985, *Farrant*, UNSW 18602; Coffs Harbour, 18-iv-1980, *Millar and Mix*, MELU AM 061; Seal Rocks, 0-2m, 10-x-1985, *P. and W. Farrant*, UNSW 18683; Tuggerah Lakes, Apr. 1911, *Lucas*, NSW A1351; Long Reef, 12-vii-1979, *Kraft and Borowitzka*, MELU GK 6921 (duplicate in UNSW: 18400); Fairlight, 1-2m, 20-iii-1986, *Farrant*, UNSW 18338; Fairlight, 1-3m, 14-v-1985, *Farrant*, UNSW 18055; Long Bay, July 1903, *Lucas*, NSW 140425; Jervis Bay, drift, 18-iii-1985, *King*, UNSW 17708. Queensland: Caloundra, Jan. 1909, *Lucas*, NSW 140451.

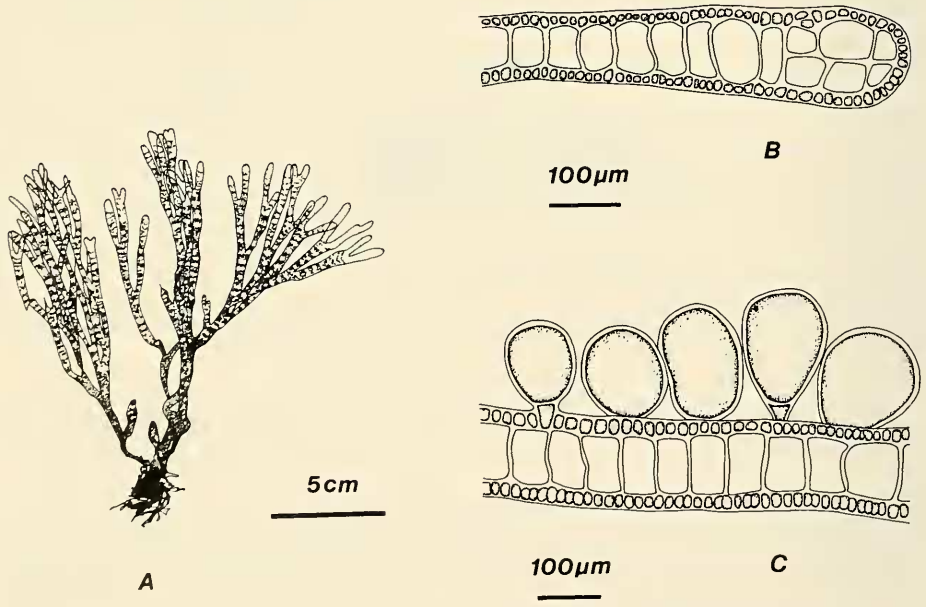


Fig. 7. Dilophus marginatus: (**A**) habit of sporangial plant, with sporangia concealing the wrinkled nature of the thallus (UNSW 18225), (**B**) T.S. frond margin (UNSW 18042), (**C**) sporangia (UNSW 18355).

Dilophus marginatus J. Agardh, 1894:91. Allender and Kraft, 1983:118; Womersley, 1987:202.

Thalli 5-18cm (usually about 10cm) long, basally stoloniferous (Fig. 7**A**); fronds 3-

6mm wide, linear, mature blades corrugated due to transverse wrinkling; hair tufts scattered; in transverse section a single-celled medulla becoming 2(-3) cells thick at the frond margins (Fig. 7**B**); sporangia (Fig. 7**C**) scattered on the frond surface, especially abundant in the corrugations.

Seasonality: present in all months, although abundance was seasonal, peaking in autumn-winter (King and Farrant, 1987); sporangial plants found in all months except December and January; no gametophytic plants known for this species.

Australian distribution: from South Australia to Queensland, and from Lord Howe Island (May, 1939; Cribb, 1954; Allender and Kraft, 1983; Womersley, 1987); common in shallow sublittoral rocky and sandy habitats and lower eulittoral pools.

Selected specimens examined: New South Wales: Hastings Point, 19-v-1986, *Phillips*, MUCV 2557; NW Solitary I., 10-16m, 6-x-1985, *Farrant*, UNSW 18606; Port Macquarie (31°27′S, 151°26′E), 21-xi-1972, *Coveny* 4737, NSW; Broughton I., 15m, 28-iv-1985, *Farrant*, UNSW 18016; Fairlight, 1-2m, 20-v-1986, *Farrant*, UNSW 18372; Clovelly, 1-3m, 28-ii-1985, *Farrant*, UNSW 17656; Long Bay, June 1915, *Lucas*, NSW; Steamers Beach, 11-vii-1979, *King and Kertesz*, UNSW 15363. Victoria: Brighton, Jan. 1900, *Lucas*, NSW.

COMPARISON WITH *DILOPHUS* SPECIES IN ADJACENT REGIONS

Species concepts in the genus *Dilophus* are unsatisfactory. Womersley (1987) has reduced the number of species on the southern Australian coast from eleven (Womersley, 1967) to seven: *D. marginatus*, *D. robustus* (J. Agardh) Womersley, *D. angustus* J. Agardh, *D. tener* J. Agardh, *D. crinitus* J. Agardh, *D. fastigiatus* (Sonder) J. Agardh, and *D. gunnianus* J. Agardh. Two of the species of *Dilophus* recorded for northern Australia, *D. intermedius* and *D. marginatus* (Lewis, 1985), are found in southern Queensland and at Lord Howe Island (Allender and Kraft, 1983).

Lobospira Areschoug

Growth apical from short rows of cells at the apices of the axes and laterals (not in the determinate laterals). **Thalli** with recurved attaching lower lateral branches, upper free branches twisted and bearing bicuspid determinate laterals; midrib present, especially in the lower half of branches; sporangia scattered and sunken in the thallus.

The monotypic genus *Lobospira* is easily distinguished from all other genera by its distinctive morphology. Growth is from a cluster of apical cells (Edelstein and Womersley, 1975).

Lobospira bicuspidata Areschoug, 1854:364. Edelstein and Womersley, 1975:149; Womersley, 1987:214.

Thalli 10-25cm long; fronds 1-2mm wide (Fig. 8**A**,**B**).

Seasonality: only one collection from New South Wales, that of Lucas in January 1910.

Australian distribution: southern Australia (from Nickol Bay, Western Australia to Eden, New South Wales) (Womersley, 1987); found from just below LWM to a depth of 13m; only collected once in New South Wales (Lucas, Eden, Jan. 1910, 10 specimens in NSW) so possibly drift from the south; not collected in this survey.

Selected specimens examined: New South Wales: Eden, Jan. 1910, *Lucas*, NSW. Victoria: Point Lonsdale, 26-ii-1979, *King*, UNSW 16018; Sandringham, Jan. 1900, *Lucas*, NSW. South Australia: Port MacDonnell, 13-iv-1975, *Harada* R2666, NSW.

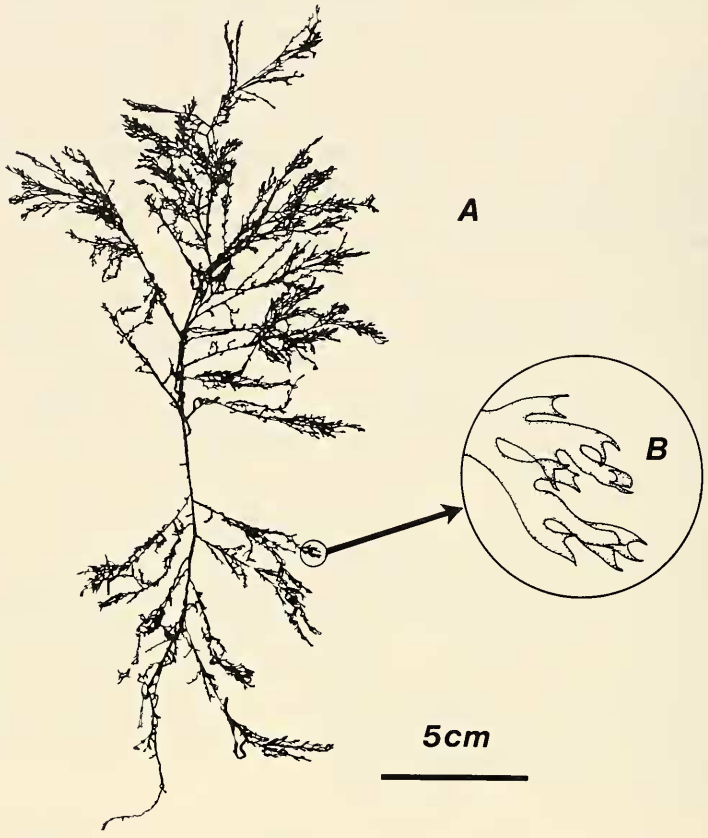


Fig. 8. Lobospira bicuspidata: (**A**) habit (Eden, Jan. 1910, A. H. S. Lucas), (**B**) frond apex.

Dictyopteris **Lamouroux**

Growth from a small group of initials generally in a slight apical depression. **Thalli** erect, smooth, flattened, membranous to coarse, mostly delicate; fronds with a conspicuous midrib, branches arising from the midrib or margins; hair clusters and reproductive organs on both surfaces; in section consisting of an inner zone of more or less cuboidal to angular colourless cells, and an outer layer of small cuboidal pigmented cells.

Dictyopteris arostichoides is the only species of *Dictyopteris* on the New South Wales coast.

Dictyopteris acrostichoides (J. Agardh) Boergesen, 1935:36. Womersley 1987:226.

Haliseris acrostichoides J. Agardh, 1882: 133.

Thalli 15-30(-55)cm long, branching often but not always from or near the midrib, with some marginal branching in upper parts; fronds (0.4-)0.8-1.0(-1.5)cm wide (Fig. 9**A**); reflexed lines of hair tufts present, no veinlets; 4(-6) cells thick except in the region of the midrib (Fig. 9**B-D**); sporangia embedded in the cortical layer (Fig. 9**B**,**C**), scattered in two distinct elongate sori, leaving the midrib area and marginal zones sterile (Fig 9**A**); fertile regions of male plants forming irregularly shaped pale patches on

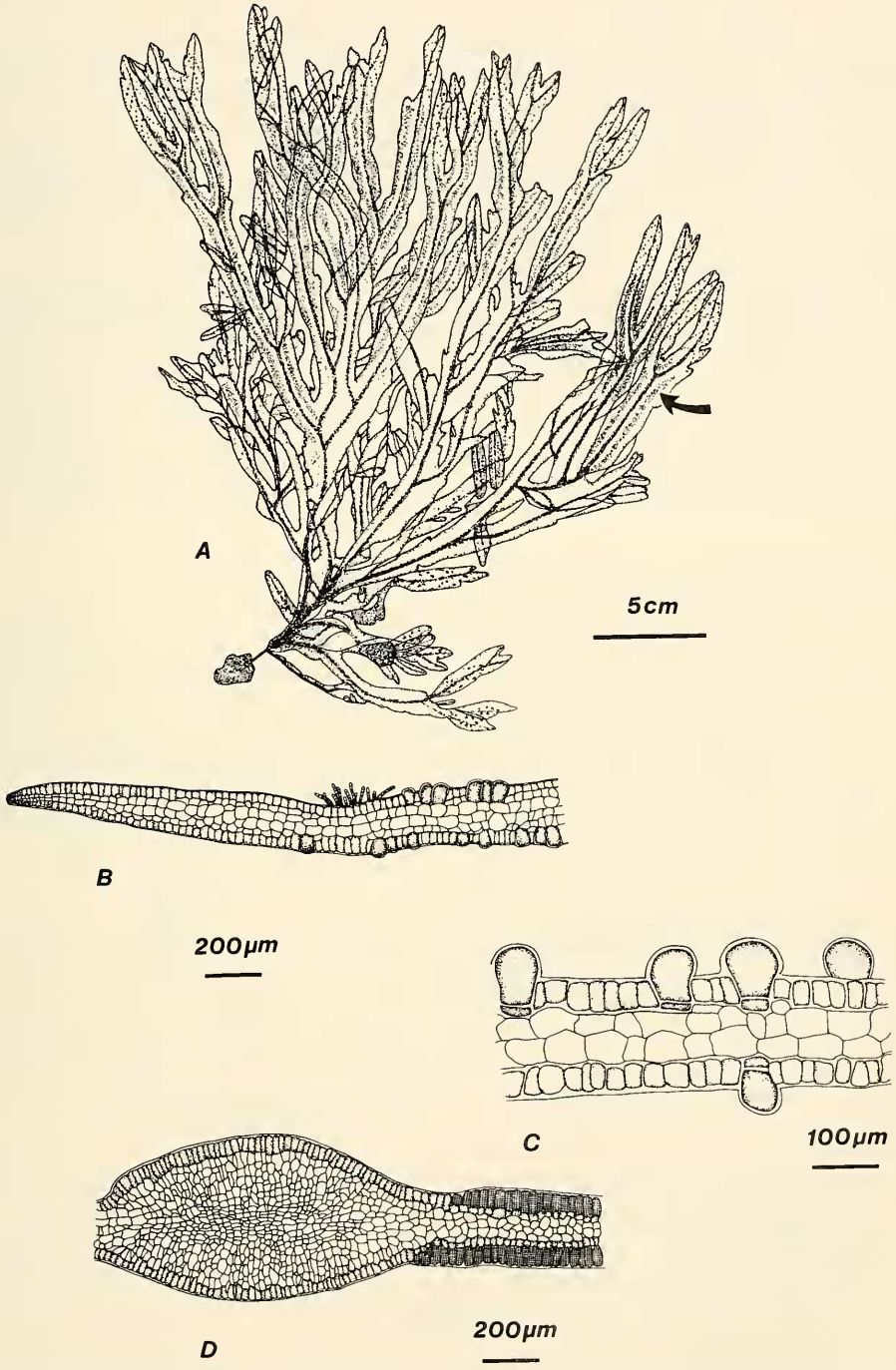


Fig. 9. Dictyopteris acrostichoides: (**A**) habit of sporangial plant, showing longitudinal sori (arrow) (UNSW 17663), (**B**) T.S. of frond showing hair tufts (UNSW 18345), (**C**) T.S. of frond showing sporangia (UNSW 17647), (**D**) T.S. of male frond showing midrib and antheridial sori (UNSW 17647).

the frond wings with antheridial sori sunken in the thallus (Fig. 9**D**); in dried herbarium material male plants difficult to distinguish from sterile plants.

Seasonality: collected in all months of the year; sporangial plants in all months except May and August; male gametophytes (Fig. 9**D**), previously unrecorded, collected in February and September from Sydney Harbour; female plants not found.

Australian distribution: from Warrnambool, Victoria, to Rockingham, Queensland, and along the northern coast of Tasmania (Womersley, 1987); many published records for New South Wales (e.g. Lucas, 1913, 1914; May, 1939; Womersley, 1949), where plants grow in the shallow sublittoral, in sheltered localities on rough water coasts and in bays.

Selected specimens examined: New South Wales: Pottsville Beach, 19-v-1986, *Phillips*, MUCV 2560; Woolgoolga, Jan. 1972, *V. May*, NSW 126974; Crescent Head, LWM, 9-x-1985, *P. and W. Farrant*, UNSW 18652; Camp Cove, 1-2m, 28-ii-1985, *Farrant and Puttock*, UNSW 17647; Lady Jane Beach, 1-3m, 28-ii-1985, *Farrant and Puttock*, UNSW 17663; Mrs Macquarie's Point, 1-2m, 13-ix-1985, *Farrant*, UNSW 18291; Point Piper, July 1899, *Lucas*, NSW; Bare I., 6m, 25-vii-1985, *Farrant*, UNSW 18246; Crookhaven Heads, LWM, 12-iv-1986, *King*, UNSW 18635. Queensland: Noosa, Nov. 1943, *V. May* 989, NSW; Margate, 21-xii-1943, *V. May* 987, NSW; Sandgate, Dec. 1913, *Lucas*, NSW.

COMPARISON WITH *DICTYOPTERIS* SPECIES IN ADJACENT REGIONS

Four species of *Dictyopteris* (*D. australis* (Sonder) Askenasy, *D. gracilis* Womersley, *D. muelleri* (Sonder) Reinbold, and *D. nigricans* Womersley) occur in southern Australia but not New South Wales (Womersley, 1987). There are five species recorded for Lord Howe Island: *D. australis* and *D. plagiogramma* (Montagne) Vickers, both of which have veinlets; *D. repens* (Okamura) Boergesen and *D. delicatula* Lamouroux, distinguished by their small size (and perhaps representing a single species); and *D. crassinervia* (Zanardini) Schmidt distinguished by its unique winged apices (Allender and Kraft, 1983). *Dictyopteris crassinervia*, *D. delicatula* and *D. repens* are also recorded from Queensland (Allender and Kraft, 1983; Ngan and Price, 1979, 1980).

REJECTED SPECIES RECORDS

Dictyopteris australis (Sonder) Askenasy: Allender and Kraft (1983) stated that *D. australis* 'is now known to occur generally around Australia.' There are in fact no records for Victoria or New South Wales though the species occurs in South Australia, Western Australia, Queensland (Womersley, 1987) and at Lord Howe Island (Allender and Kraft, 1983). The species is similar to *D. acrostichoides*, but is easily distinguished by the presence of fine lateral veins and by the distribution of the sori and associated hair tufts in reflexed lines. The frond wings of *D. australis* are generally distromatic rather than of four or more cells as in *D. acrostichoides*.

Dictyopteris muelleri (Sonder) Reinbold: Harvey's specimen of *D. muelleri* (NSW 140374, Harv. Alg. Austr. Exsic. n. 87, 1855) was referred to by May (1939) and on that basis Womersley (1987) recorded *D. muelleri* for New South Wales. The specimen has no collecting locality. Harvey (1860) listed Port Jackson, New South Wales as a collecting locality but he stated that the species was rare on the east coast. The species record for New South Wales therefore has no reliable herbarium voucher specimen and the species has not been recorded otherwise from New South Wales. *Dictyopteris muelleri* has a southern Australian distribution and is easily distinguished from *Dictyopteris acrostichoides* by the evenly scattered hair tufts which are not arranged in reflexed lines; fertile *D. muelleri* material is easily recognized, since sporangia, oogonia and antheridial sori

occur in broad bands across the thallus and the midrib and marginal regions are sterile (J. Phillips, *pers. comm.*).

Dictyopteris plagiogramma (Montagne) Vickers: although Allender and Kraft (1983) recorded this species from the Coffs Harbour region of New South Wales, there is no herbarium voucher specimen (A. Miller and G. Kraft, *pers. comm.*). *Dictyopteris plagiogramma* occurs at Lord Howe Island (Allender and Kraft, 1983) and in northern Australia (Lewis, 1985). It is distinguished from *D. acrostichoides* by the presence of fine lateral veins and by the arrangement of hair tufts in single longitudinal rows on each side of the midrib.

Dictyopteris woodwardii (R. Brown ex Turner) Schmidt: was recorded for Ballina by Sonder (1871) as *Halyseris polypoidioides* var. *woodwardia*. This was based on a specimen in MEL (584114) which has been annotated by B. M. Allender (12-vii-1981) as *D. acrostichoides*. *Dictyopteris woodwardii* is otherwise recorded for northern Australia (Lewis, 1985). The species is distinguished from *D. acrostichoides* by having frond margins fringed with minute spine-like teeth.

Spatoglossum Kuetzing

Growth initiated by a group of apical cells. **Thalli** broad, complanate; fronds branching irregularly, hair tufts scattered; sporangia scattered and sunken in the frond surface.

Spatoglossum macrodontum is the only species of the genus in New South Wales.

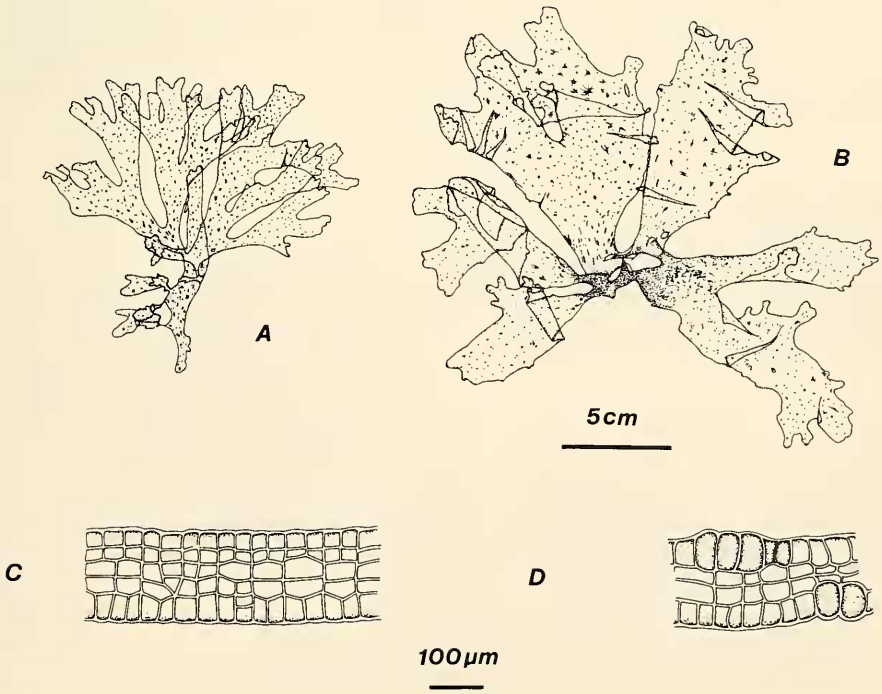


Fig. 10. Spatoglossum macrodontum: (**A**) habit of small plant (UNSW 17740), (**B**) habit of large broad plant (UNSW 18714), (**C**) T.S. frond (UNSW 18251), (**D**), section through sporangia (UNSW 17791).

Spatoglossum macrodontum J. Agardh, 1882:113. Allender and Kraft, 1983:100.

Thalli 10-35cm long, medium to dark brown (drying to a greenish-brown colour); fronds 3-8cm wide, complanate; branching irregular with unequal development of dichotomies, margins smooth in young plants (Fig. 10**A**) but irregular to dentate in older, larger plants (Fig. 10**B**); 4-6 cells thick and cells arranged irregularly (Fig. 10**C**); sporangia scattered and sunken in the frond surface (Fig. 10**D**).

Seasonality: collected in all months except February, but seasonally abundant, with young plants present at the end of winter and early spring; sporangial plants collected in most months in this study and spent male gametangial plants in June, July and August.

Australian distribution: Jervis Bay, New South Wales, north to Queensland and the Northern Territory, and at Lord Howe Island (Allender and Kraft, 1983; Lucas, 1909, 1914; May, 1939); locally abundant in the shallow sublittoral.

Selected specimens examined: New South Wales: Port Stephens, June 1909, *Lucas*, NSW 140350; Port Stephens, 0-2m, 11-x-1985, *P. and W. Farrant*, UNSW 18714; Vaucluse, 1m, 21-xi-1985, *Farrant*, UNSW 18577; Mrs Macquarie's Point, 2-3m, 29-vii-1985, *Farrant*, UNSW 18251; Mrs Macquarie's Point, 2m, 27-vi-1985, *Farrant and Puttock*, UNSW 18208; Jervis Bay, 9-x-1941, *V. May* 983, NSW. Queensland: Magnetic I., 15-v-1987, *Phillips*, MUCV 2565; Redcliffe, 5-vi-1980, *Alderslade* R3988, NSW.

COMPARISON WITH *SPATOGLOSSUM* SPECIES IN ADJACENT REGIONS

Spatoglossum macrodontum as well as two other species, *S. asperum* J. Agardh and *S. shroederi* (Mertens) J. Agardh, have been recorded from northern Australia (Lewis, 1985). *Spatoglossum macrodontum* is the only species found at Lord Howe Island (Allender and Kraft, 1983). *Spatoglossum macrodontum* appears to be closely related to *S. australasicum* Kuetzing from South Australia, but there is little material (and no fertile material) of *S. australasicum* available for comparison (Womersley, 1987).

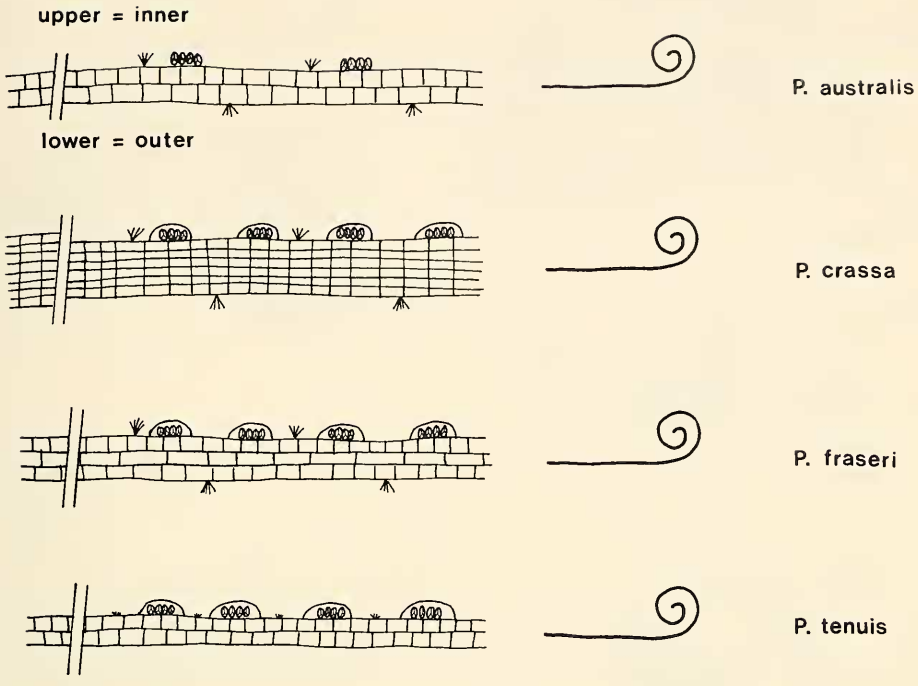
Padina Adanson

Growth from a marginal row of apical cells. **Thalli** flabellate with inrolled margins, calcified to various degrees.

Four species of *Padina* occur on the New South Wales coast: *Padina australis* which is not common, *P. crassa*, *P. fraseri*, and *P. tenuis*. The four species, especially the last two, are difficult to separate without sectioning and/or reproductive material (Fig. 11).

KEY TO THE SPECIES OF *PADINA* IN NEW SOUTH WALES

1. Thallus 2 cells thick throughout 2
1.* Thallus more than 2 cells thick except near the apex 3
2. Sporangia on upper surface in concentric lines bordered on each side by hair bands that alternate on upper and lower surfaces; sporangial regions separated from each other by sterile zones ..... *P. australis*
2.* Sporangia on upper surface in concentric lines bordered on each side by hair bands that are only on the upper surface; sporangial regions not separated from each other by sterile zones ..... *P. tenuis*
3. Thallus 3 cells thick throughout ..... *P. fraseri*
3.* Thallus 6-10 cells thick ..... *P. crassa*



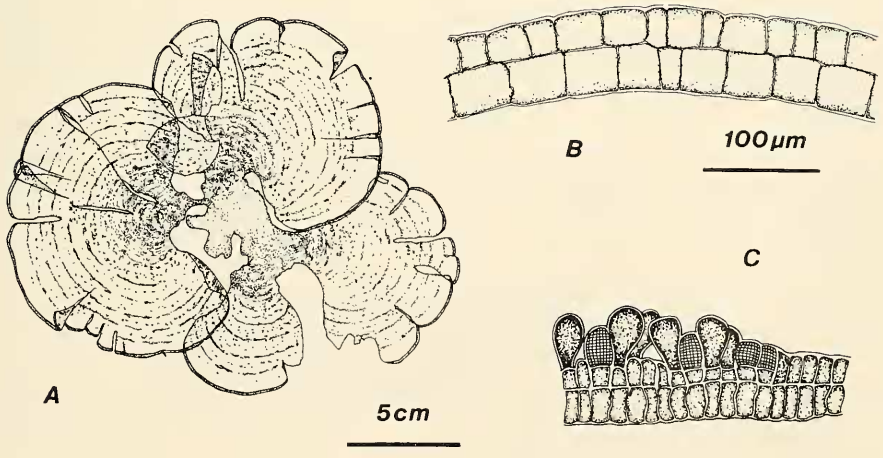


Fig. 11 (above). Diagram showing distribution of hairs and sori on New South Wales species of *Padina* (not to scale).

Fig. 12 (below). *Padina australis:* (**A**) habit of gametangial plant (UNSW 17705), (**B**) T.S. top of frond (UNSW 17705), (**C**) section through female and male gametangia (UNSW 17705).

Padina australis Hauck, 1887:44. Allender and Kraft, 1983:85.

Thalli 6-10cm long; fronds 4-12cm wide (Fig. 12**A**), with conspicuous hairs on both surfaces, hair lines 1-1.5mm apart; distromatic throughout (Fig. 12**B**); gametangial plants monoecious, with female and male gametangia in mixed sori (Fig. 12**C**) on the upper (inner) frond surface, alternating fertile and sterile zones.

Seasonality: collected in February and March only, from Church Point, Pittwater; gametangial plants present in both collections; no sporangial plants found.

Australian distribution: reported from Lord Howe Island, and in mainland Australia from the central New South Wales coast to the Northern Territory (Allender and Kraft, 1983); in this survey found on rocks just below low water mark in a very sheltered part of the estuary.

Selected specimens examined: New South Wales: Lord Howe I., 14-v-1977, *Kraft*, MELU A037276; Lord Howe I., 16-xii-1986, *Kraft and Millar*, MELU A037275; Church Point Pittwater, LWM, 17-iii-1985, *Farrant*, UNSW 17705.

Padina crassa Yamada, 1931:67. Allender and Kraft, 1983:87.

Thalli 6-16cm long; fronds 3-10cm wide (Fig. 13**A**), hairs conspicuous, in alternating rows on each frond surface, (2-)4-5(-7.5)mm apart; fronds 6-8(-10) cells thick except at the apex (Fig. 13**B**,**C**); sporangial sori indusiate (Fig. 13**B**) and mainly on the upper (inner) side of the frond (occasionally on both surfaces), fertile zones not separated by sterile zones.

Padina crassa specimens from the New South Wales mainland coast agree with Allender and Kraft's (1983) Lord Howe Island material in that they have no sterile zones, have the same seasonality and indusiate sori. The mainland material has hairs on both frond surfaces whereas the Lord Howe Island plants have them only on the upper surfaces.

Allender and Kraft (1983) stated that 'there is little if any significant difference between . . . *P. gymnospora* and *P. crassa* from the eastern and southern Pacific'. Womersley (1987) recorded *P. gymnospora* (Kuetzing) Sonder in southern Australia, noting that it has a distribution extending into warm temperate waters on both eastern and western coasts of Australia. He noted however that, according to Allender and Kraft (1983), *P. crassa* from Lord Howe Island has sori on the outer (lower) surface only, whereas in *P. gymnospora* the sori are mainly (but not only) on the upper surface.

Allender and Kraft (1983) attempted to clarify the confusion which 'surrounds the terminology used to describe the morphology and anatomy of the species' of *Padina* and correctly defined the use of the terms inner and outer, the inner being the 'side towards which the marginal curl is directed'. In their descriptions of *P. australis*, *P. crassa* and *P. tenuis* Allender and Kraft stated that the sporangial sori are located on the outer frond surfaces, and in their fig. 6 the outer surface is correctly referred to as the 'upper' surface. We have examined fertile specimens of all these species from Lord Howe Island (MELU A037276, MELU A037275, MELU GK9560, MELU A037274) and of *P. fraseri* from Victoria (MELU 4290), and the sori in all cases occur on the surface to which the marginal roll is directed, i.e., the inner surfaces. The descriptions of these species in Allender and Kraft (1983) should therefore read sporangial sori on inner frond surface rather than outer. The inner surface is then equivalent to the upper surface in the terminology used by Womersley (1987).

The material from New South Wales and Lord Howe Island thus differs from *Padina gymnospora* in that it has indusiate sori whereas *P. gymnospora* has essentially non-indusiate sori. *Padina gymnospora* and the New South Wales specimens have hairs on both surfaces whereas the Lord Howe Island species has hairs on the upper surface only. The

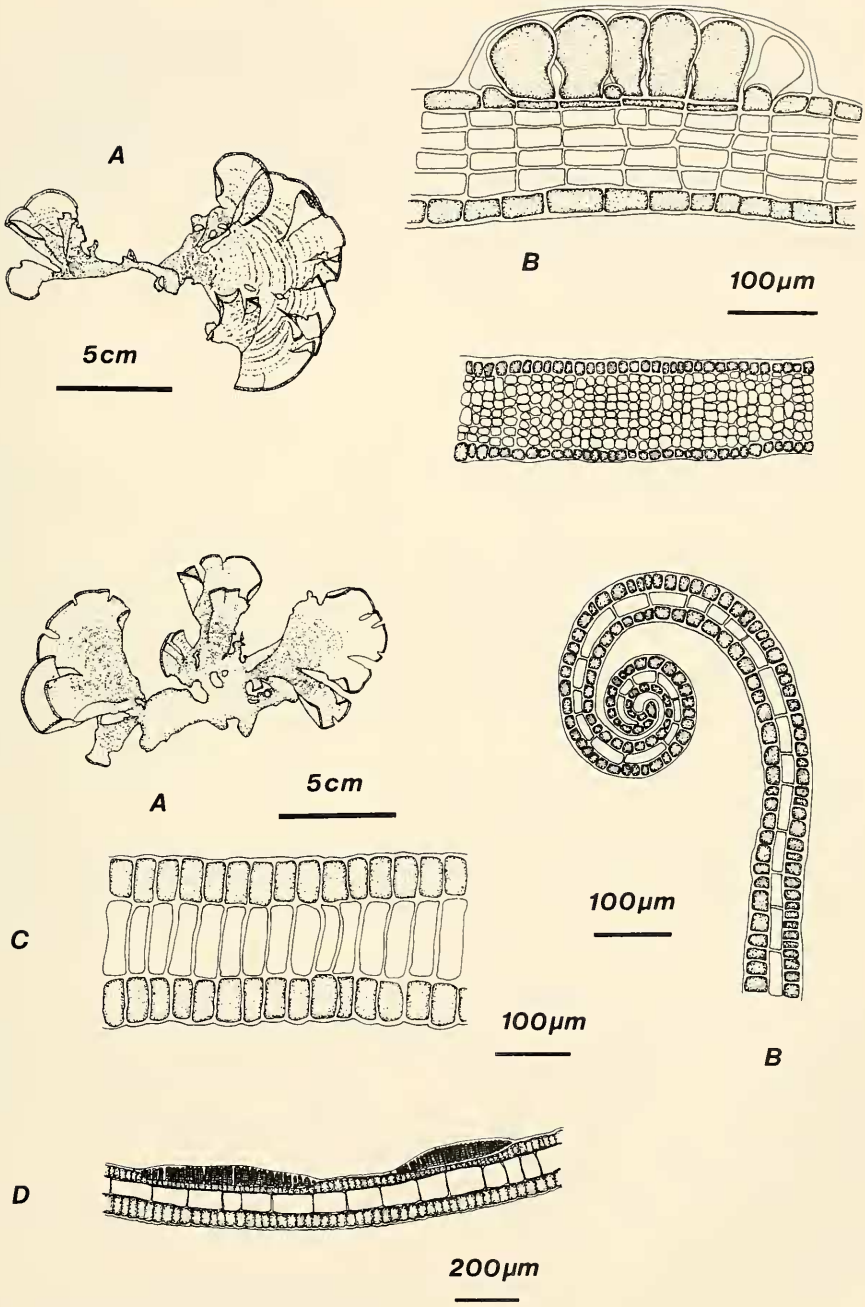


Fig. 13 (above). *Padina crassa:* (**A**) habit (UNSW 18041), (**B**) sporangial sorus (UNSW 17766), (**C**) base of frond (UNSW 18803).
Fig. 14 (below). *Padina fraseri:* (**A**) habit (UNSW 18685), (**B**) L.S. apex (UNSW 18002), (**C**) T.S. base of frond (UNSW 18685), (**D**) section through male sorus (UNSW 17665).

relationship between these two taxa deserves attention; examination of type specimens may show that the two are not distinct.

Seasonality: absent in the winter months; sporangial plants collected in the warmer months (King and Farrant, 1987); no gametangial plants collected.

Australian distribution: Lord Howe Island (Allender and Kraft, 1983) and in Queensland (UNSW 16036); in this survey north to Hastings Point and south to Jervis Bay; found in the shallow upper subtidal, on the open coast and in bays and estuaries.

Selected specimens examined: New South Wales: Hastings Point, 19-v-1986, *Phillips*, MUCV 2563; Coffs Harbour, 2-4m, 4-x-1981, *Farrant*, UNSW 18041; South West Rocks, LWM, 9-x-1985, *P. and W. Farrant*, UNSW 18637; Lord Howe I., 9-xii-1978, *Kraft and Ricker*, MELU GK 9560; Fairlight, 1m, 29-i-1986, *Farrant*, UNSW 18829; Vaucluse, 1m, 18-iv-1985, *Farrant and Puttock*, UNSW 17790; Jervis Bay, LWM, 18-iii-1985, *King*, UNSW 17709. Queensland: Noosa, 4-xii-1976, *King and Kertesz*, UNSW 16036.

Padina fraseri (Greville) Greville, 1830, synop.:xliv. Womersley, 1987:217.

Thalli 6-9.5cm long, often distinctly crinkled; fronds 3-7.5cm wide (Fig. 14**A**), with alternate concentric hair lines on both sides of the fronds, (2-)4(-7)mm apart; 3 cells thick almost to the apex (Fig. 14**B**), with central (medullary) cells larger than cortical cells (Fig. 14**B-D**); sporangial sori indusiate, no sterile zones between hair lines; male gametangial plants with indusiate antheridial sori (Fig. 14**D**).

Padina pavonica (Linnaeus) Lamouroux has been recorded for Port Jackson, New South Wales (May, 1939) and generally for New South Wales and Lord Howe Island (Lucas, 1909, 1914, 1935). This species differs from *P. fraseri* in not having the central (medullary) cells longer than the outer cells (Allender and Kraft, 1983: fig. 6D,F). The records of *P. pavonica* for New South Wales probably mostly refer to *P. fraseri*, since the NSW specimens that have been examined in the present study, and which are 3 cells thick, have longer central cells and a crinkled thallus, and therefore appear to belong to *P. fraseri*.

Seasonality: sporophytic plants collected especially in the warmer months, and male plants, the first sexual plants to be recorded for the species, collected in February.

Australian distribution: recorded from south-eastern Australia from Warrnambool, Victoria, to the mid north New South Wales coast (Womersley, 1987); grows at and just below low water mark, on rocky open coasts.

Selected specimens examined: New South Wales: Crescent Head, LWM, 9-x-1985, *P. and W. Farrant*, UNSW 18649; Seal Rocks, 0-2m, 10-x-1985; *P. and W. Farrant*, UNSW 18680; Lady Jane Beach, 1-3m, 28-ii-1985, *Farrant and Puttock*, UNSW 17665; Wollongong, Jan. 1912, *Lucas*, NSW; Kiama, Dec. 1899, *Lucas*, NSW; Crookhaven Heads, LWM, 20-iv-1985, *Farrant*, UNSW 18002; Merimbula, 19-viii-1987, *D. May* MUCV 2575. Victoria: Barwon Heads, 7-ii-1969, *Ducker*, MELU 4290; Apollo Bay (38°46′S, 143°44′E), 23-i-1967, *Womersley*, NSW ex ADU A31758.

Padina tenuis Bory, 1827:590. Womersley and Bailey, 1970: 292; Allender and Kraft, 1983:83.

Thalli 6-18cm long; fronds 3-12cm wide (Fig. 15**A**), without conspicuous hairs below the first hair line, hair scar lines (1.5-)3-4(-6)mm apart; fronds distromatic throughout (Fig. 15**B**,**C**); sporangial sori indusiate (Fig. 15**B**) or have the remains of an indusium, fertile zones not separated by sterile zones.

The New South Wales specimens of *Padina tenuis* agree well with Allender and Kraft's (1983) description of the species for Lord Howe Island and the southern Great

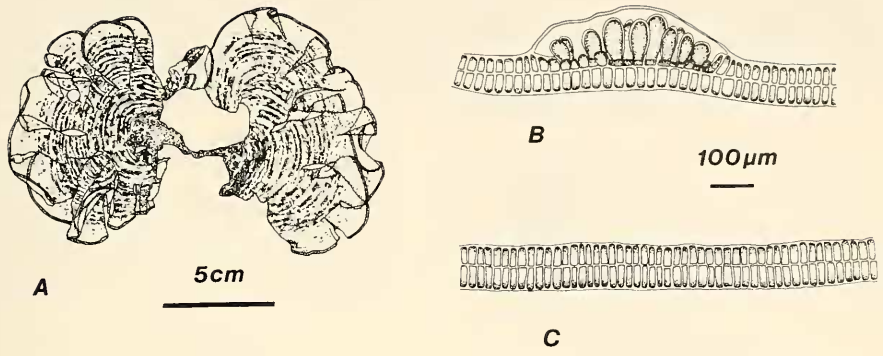


Fig. 15. Padina tenuis: (**A**) habit (UNSW 18068), (**B**) T.S. base of frond through sporangial sorus (UNSW 18583), (**C**) T.S. base of frond (UNSW 18583).

Barrier Reef, except that their material has non-indusiate sori and the fronds are 2-3 cells at the base. Almost all New South Wales specimens have indusiate sori and are 2 cells thick throughout. Lord Howe Island material examined during the present study (MELU A037274) showed that the remains of indusia were present. The New South Wales and Lord Howe Island specimens therefore appear to belong to the same taxon, *P. tenuis*, although examination of type material would be required to confirm this.

Seasonality: collected in all months, sporangial plants in all months except July, August and October; no gametophytic plants present.

Australian distribution: recorded for Lord Howe Island and the southern Great Barrier Reef (Allender and Kraft, 1983) but not reported previously for the mainland coast of New South Wales; grows from a depth of several metres to 16m, on both sheltered and open coast shores.

Selected specimens examined: New South Wales: Pottsville Beach, 19-v-1986, *Phillips*, MUCV 2559; NW Solitary I., 10-16m, 6-x-1985, *Farrant*, UNSW 18608; Lord Howe I., i-xii-1978, *Kraft and Ricker*, MELU A037274 (=GK 9405); Broughton I., 15m, 28-iv-1985, *Farrant*, UNSW 18015; Barrenjoey, 15m, 23-iii-1985, *Farrant*, UNSW 17728; Mrs Macquarie's Point, 1-2m, 26-iii-1986, *Farrant and Puttock*, UNSW 18341; Long Bay, Apr. 1900, *Lucas*, NSW.

COMPARISON WITH *PADINA* SPECIES IN ADJACENT REGIONS

Padina australis, *P. crassa* and *P. tenuis* occur at Lord Howe Island (Allender and Kraft, 1983). *Padina boergesenii* Allender and Kraft was described on the basis of Lord Howe Island material (Allender and Kraft, 1983). It is rare and has not been recorded for the New South Wales mainland coast, although Allender and Kraft (1983) suggest that it probably occurs in Queensland. *Padina tetrastromatica* Hauck, which occurs in Queensland, is similar to *P. fraseri* except that it becomes 4-layered in older thallus parts (Allender and Kraft, 1983: fig. 6E). *Padina fraseri* is the only species of *Padina* for most of the southern Australian coast, with three other species now recognized from the western end of that region: *P. elegans* Koh *ex* Womersley, *P. gymnospora* (Kuetzing) Sonder, and *P. sanctae-crucis* Boergesen (Womersley, 1987).

Distromium Levring

Growth from a marginal row of apical cells. **Thalli** two cells thick throughout (3 cells thick at hairs).

There is only one species of *Distromium* (*D. flabellatum*) in New South Wales. The plants are relatively small compared with those reported from southern Australia, and no fertile plants have been seen in the New South Wales material. Therefore the identification to specific level is provisional since fertile material is required to establish its relationship with *D. skottsbergii* Levring (Womersley, 1967; Lindauer *et al.*, 1961).

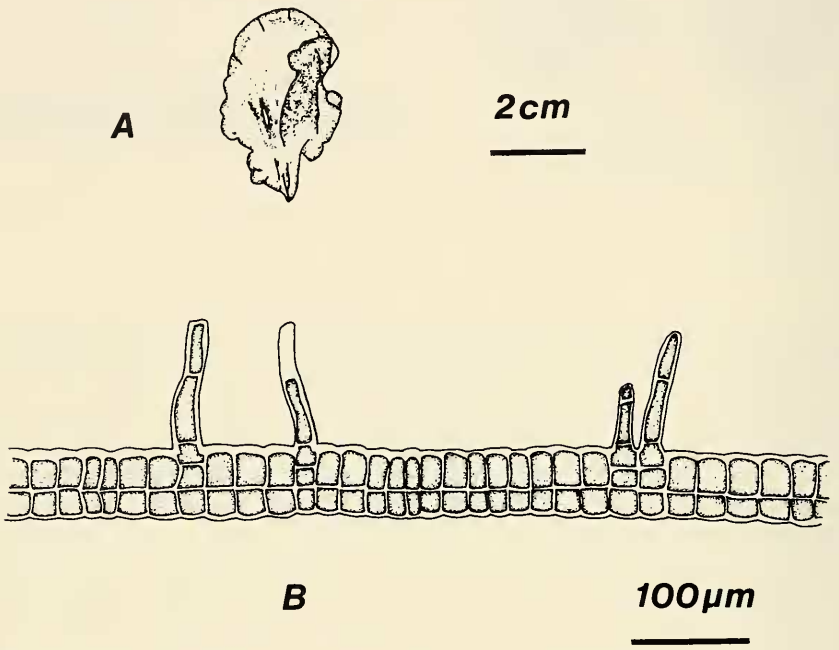


Fig. 16. Distromium flabellatum: (**A**) habit (UNSW 18849), (**B**) section of frond (UNSW 18873).

Distromium flabellatum Womersley, 1967:218. Womersley, 1987:230.

Thalli 2-3cm long, slightly blue-green when seen *in situ*; frond(s) 2-3cm wide (Fig. 16**A**), flabellate; hairs borne singly (Fig. 16**B**).

Seasonality: collected in this study in April and September; no reproductive plants found.

Australian distribution: recorded from 7 Mile Beach, north of Dongara, Western Australia and along the southern Australian coast to Deal I. in Bass Strait (Womersley, 1987); now tentatively recorded for New South Wales; in this study collected at only one locality (Fairlight, Sydney Harbour) on the vertical face of a rocky reef at 4-5m depth; may be more widespread, but is easily overlooked because of its superficial similarity to young *Zonaria diesingiana* plants, which however differ by being 6-8 cells thick.

Selected specimens examined: New South Wales: Fairlight, 5m, 29-iv-1986, *Farrant*, UNSW 18849; Fairlight, 4m, 25-ix-1986, *Farrant*, UNSW 18873 (wet material only); South Australia: Aldinga (35°20′S, 138°28′E), 17-ix-1966, *Womersley*, NSW ex ADU A30711.

COMPARISON WITH *DISTROMIUM* SPECIES IN ADJACENT REGIONS

Distromium flabellatum is distinguished from the Lord Howe Island species, *D. didymothrix* Allender and Kraft, by having hairs borne singly, rather than in pairs derived from a single cell (Allender and Kraft, 1983). There are two species of *Distromium* in

southern Australia: *D. flabellatum* and *D. multifidum* Womersley. The latter has linear, subdichotomous branches with small sporangial sori in the upper concave parts; the thallus lacks prominent zones of hairs which the larger southern Australian *D. flabellatum* plants have (Womersley, 1987).

Lobophora J. Agardh

Growth from a marginal row of apical cells. **Thalli** flabellate or irregularly lobed, erect or prostrate; fronds in section having medullary cells in regular tiers, with the central layer of cells larger.

One species, *Lobophora variegata*, has been recorded for New South Wales.

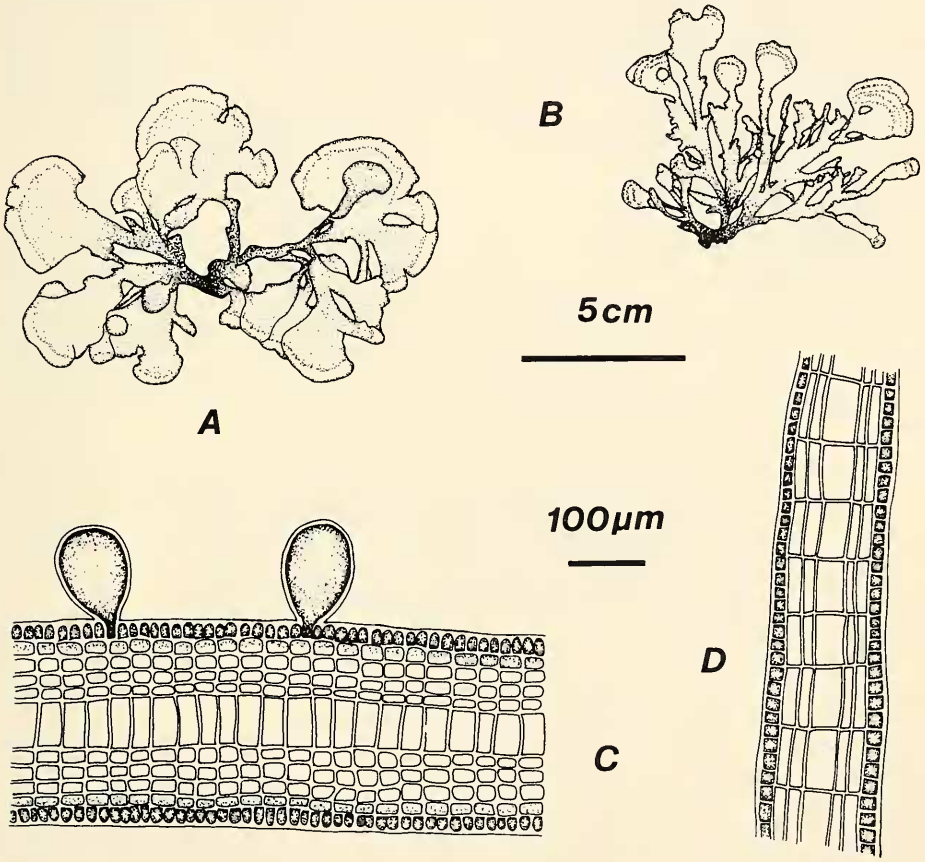


Fig. 17. Lobophora variegata: (**A**) habit of broad erect form (UNSW 18018), (**B**) habit of narrow form (UNSW 17637), (**C**) T.S. of sporangial frond (UNSW 18029), (**D**) L.S. frond (UNSW 18018).

Lobophora variegata (Lamouroux) Womersley, 1967:221. Allender and Kraft, 1983:81.
Gymnosorus variegatus (Lamouroux) J. Agardh 1894:11;
Pocockiella variegata (Lamouroux) Papenfuss 1943:467

Thalli 3-11cm long; fronds 3-6cm wide (Fig. 17**A**,**B**); in transverse section the medulla usually 9 cells thick (Fig. 17**C**), less near the apex (Fig. 17**D**), cells arranged in

regular tiers with the central cells larger than the outer cells; sporangia in isolated sori on the fronds.

Young *Lobophora variegata* plants may be confused with young *Zonaria diesingiana* plants, but the latter lack the central layer of larger medullary cells.

Seasonality: sporangial plants collected in all months; gametangial plants not present in collections.

Australian distribution: tropical and temperate coasts of Australia (Womersley, 1987), with numerous records for New South Wales and Lord Howe Island (May, 1939; Lucas, 1914, 1935; Allender and Kraft, 1983; Lindauer *et al.*, 1961; Sonder, 1880); grows on rocky substrata in the subtidal to at least 25m, and common in kelp communities.

Selected specimens examined: New South Wales: Coffs Harbour, 1-2m, 8-x-1985, *P. and W. Farrant*, UNSW 18623; Broughton I., 28-iv-1985, *Farrant*, UNSW 18029; Lord Howe I., Sep. 1908, *Dun and Hedley*, NSW 140443; Long Reef, 12-viii-1974, *Harada* R1269, NSW; Fairlight, 1-3m, 14-v-1985, *Farrant*, UNSW 18054; Dobroyd, 10m, 24-ix-1985, *Farrant*, UNSW 18533; Jervis Bay, LWM, 18-iii-1985, *King*, UNSW 17710. Queensland: Magnetic I., 13-v-1987, *Phillips*, MUCV 2568; Caloundra, Jan. 1909, *Lucas*, NSW 140438; Moreton Bay, Dec. 1913, *Lucas*, NSW 140437.

Zonaria C. Agardh

Growth from a marginal row of apical cells. **Thalli** with fronds in section having moderately distinct cortex and medulla, with medullary cells arranged in vertical tiers and cortical cells mostly paired to each medullary cell; sporangia with 8 aplanospores.

There are three species of *Zonaria* in New South Wales, *Z. diesingiana*, *Z. crenata* and *Z. angustata*. The New South Wales specimens formerly referred to *Zonaria sinclairii* Hooker and Harvey are now placed in *Homoeostrichus* (see below). The taxon referred to as '*Zonaria* sp.' in King and Farrant (1987) is *Homoeostrichus olsenii*.

KEY TO THE SPECIES OF *ZONARIA* IN NEW SOUTH WALES

1. Thallus narrow 2-4mm wide, linear, 10 cells thick, sporangial sori lacking cellular paraphyses ..... *Z. angustata*
1.* Thallus lobed or fan-shaped (to 6cm wide), or linear with cuneate terminal segments (to 2cm wide), 6(-8) cells thick, sporangial sori containing paraphyses 2
2. Thallus with lobed fronds somewhat denuded below, 6 cells thick, often covered by a network of hydroid ..... *Z. crenata*
2.* Thallus lobed or broadly fan-shaped, not denuded below, (6-)8 cells thick, not covered by hydroid ..... *Z. diesingiana*

Zonaria angustata (Keutzing) Papenfuss, 1952: 170. Womersley, 1987:248.

Thalli 15-17cm long; fronds generally 2-4mm wide, more or less linear (Fig. 18**A**) but occasionally broader (to 20mm) in young plants or at the base; in section 10 cells thick (Fig. 18**B**); sporangial sori scattered on the distal frond surfaces, without cellular paraphyses.

Seasonality: New South Wales collections of *Zonaria angustata* made in January and August only.

Australian distribution: from Elliston, South Australia, to Eden in New South Wales and around Tasmania; only two collections from New South Wales, from Eden and Green Cape, from the shallow sublittoral, 1-3m.

Selected specimens examined: New South Wales: Eden, Jan. 1910, *Lucas*, NSW 140420; Green Cape, 1-3m, 17-viii-1987, *D. May*, MUCV 2571. Victoria: Newfield Bay

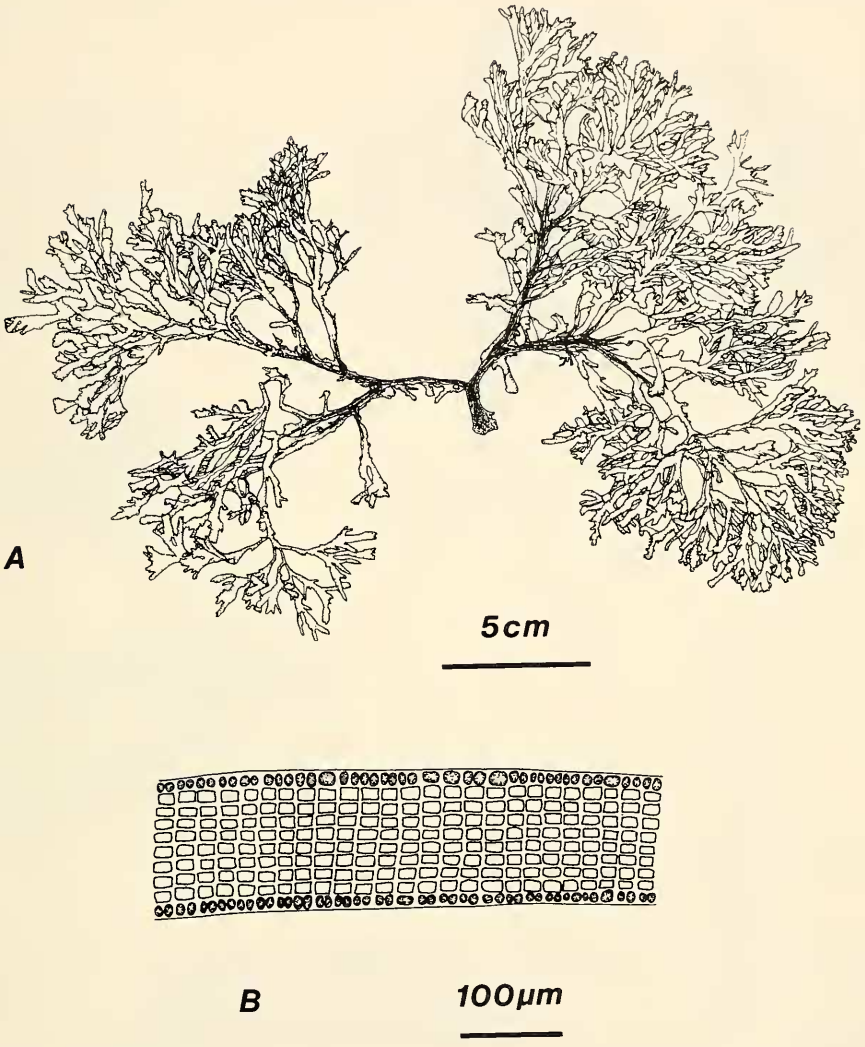


Fig. 18. Zonaria angustata: (**A**) habit (Eden, Jan. 1910, A. H. S. Lucas), (**B**) T.S. frond (MUCV 2571).

(38°36′S, 142°51′E), 10-xii-1969, *Womersley*, NSW ex ADU A3408; Point Lonsdale, 4-xii-1985, *Phillips*, UNSW 19328.

Zonaria crenata J. Agardh 1872:48, 1894:13. Womersley 1987:250.

Thalli 5-15cm long; fronds 1-2cm wide, complanate, broader at the apex and usually denuded at the base (Fig. 19**A**), covered with a network of the hydroid *Scoresbia diadala* Watson (Fig. 19**B**,**C**); 6(-8) cells thick; sporangial sori scattered on the upper parts of the fronds.

Plants of *Z. crenata* are often longer than those of *Z. diesingiana* and have narrower and thinner fronds. They are often distinguished by the hydroid cover, though this feature alone is not sufficient for species identification. New South Wales specimens can

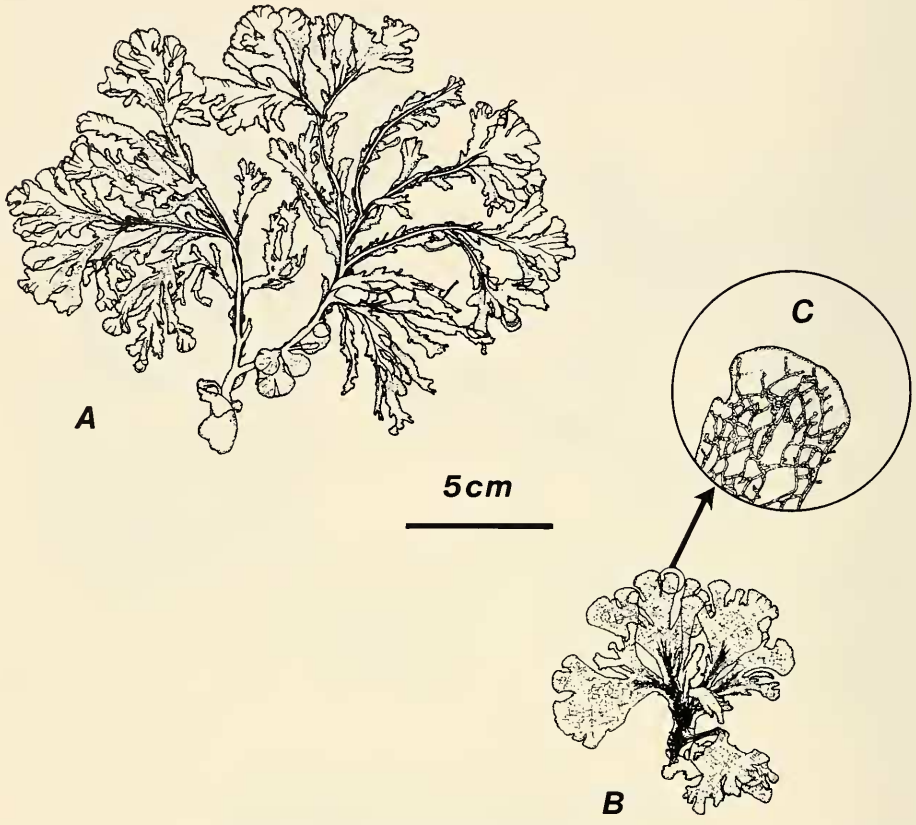


Fig. 19. Zonaria crenata: (**A**) habit (MEL 16937), (**B**) habit of plant doubtfully distinct from *Z. diesingiana* but which is 6 cells thick and has hydroid cover (UNSW 17720), (**C**) frond apex.

be difficult to place and there is considerable overlap between the two species with regard to characters such as frond thickness, frond shape and size, and the degree of hydroid cover. Some *Z. crenata* plants have a form similar to *Z. diesingiana*, with fronds 6 cells thick, complanate with broad tips and denuded lower axes and a cover of hydroid (Fig. 19**B**,**C**). Some Queensland specimens also have the typical *Z. diesingiana* form and yet have a cover of hydroid. The only typical *Z. crenata* specimens from New South Wales seen during this study were those collected from Sydney last century (MEL 16937). The relationship between the two taxa requires elaboration especially as *Z. diesingiana* is not recorded in southern Australia (Womersley, 1987).

Seasonality: not determined.

Australian distribution: from Fremantle, Western Australia, to Southport, Queensland, but rare in New South Wales; specimens examined by Womersley (1987) are either from the drift or from deep water.

Selected specimens examined: New South Wales: Coffs Harbour, 29-viii-1980, *Millar and Kraft*, MELU AM 312 and MELU AM 313; Barrenjoey, 15m, 23-iii-1985, *Farrant*, UNSW 17720; Sydney, ex Herb. Sonder (1812-1881), MEL 16937; Plantation Point, 29-viii-1973, *V. May*, NSW; Green Point Warrah Sanctuary, 17-xii-1972, *Larkum and Martin*, NSW 140433. Queensland: Mooloolaba, 24-i-1944, *V. May* 897, NSW. South Australia: Lefevre Peninsula, ex Herb. *Sonder* (1812-1881), MEL 16936, 16938; Glenelg,

22-viii-1946, *V. May 2235*, NSW; Kingston (36°50′S, 139°51′E), 16-x-1986, *Womersley*, NSW ex ADU A57343.

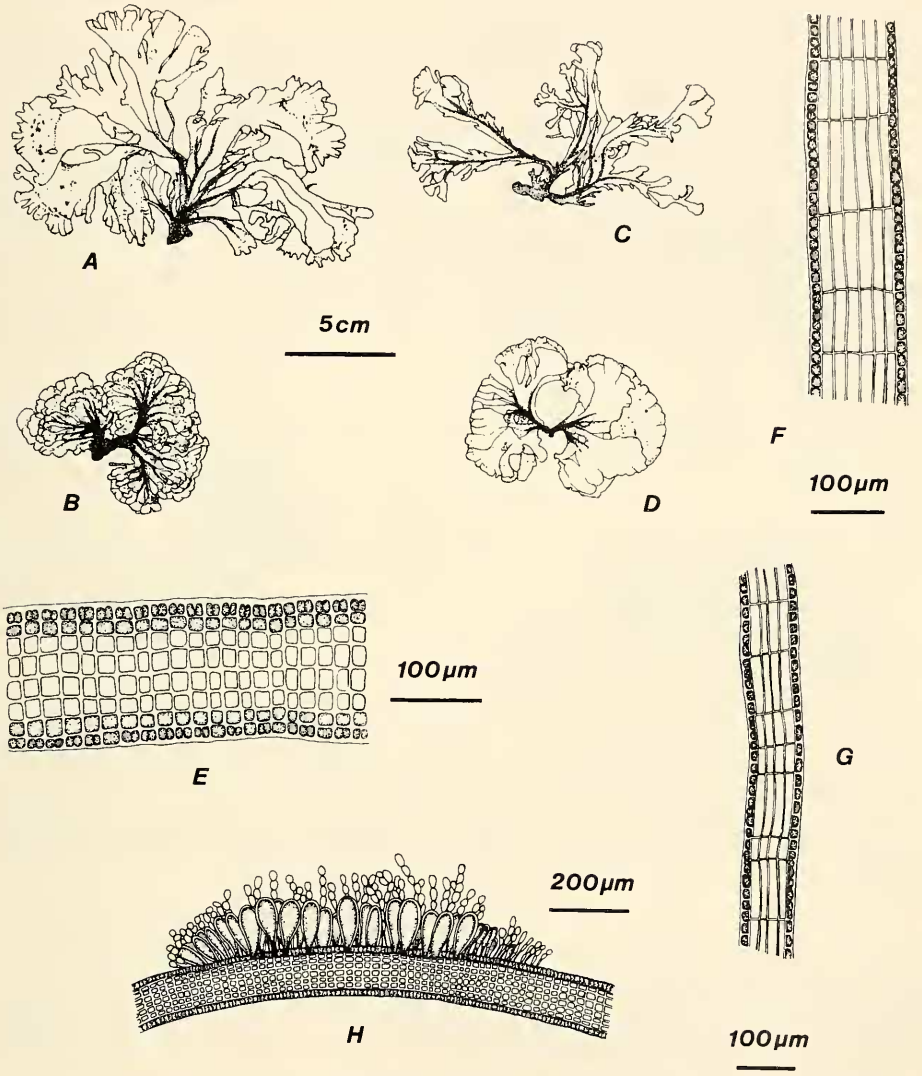


Fig. 20. Zonaria diesingiana: (**A**) habit of broad tall plant (UNSW 18019), (**B**) habit of plant with dense fronds (UNSW 18085), (**C**) UNSW 18292, (**D**) habit of broadly flabellate plant (UNSW 18022), (**E**) T.S. frond (UNSW 18085), (**F**) L.S. frond (UNSW 17755), (**G**) L.S. frond (UNSW 18008), (**H**) T.S. through sporangial sorus (UNSW 18006).

Zonaria diesingiana J. Agardh, 1841:443; 1848:109. Allender and Kraft, 1983:77.

Thalli (1.5-)4-11cm long, variable in habit, from erect to recumbent, often with a slight green or blue iridescence *in situ*; fronds to 1.5-6cm wide, from linear to broad and flabellate (Fig. 20**A-D**), basal fronds often with a stupose central axis, but never completely bare of lateral membranous frond material; (6-)8 cells thick in mid-frond

regions (Fig. 20**E-G**); sporangial plants with sori arranged irregularly or in roughly concentric lines, and with sterile paraphyses (Fig. 20**H**).

There are problems in distinguishing *Zonaria diesingiana* from *Z. crenata* in New South Wales (see notes under that species).

Zonaria turneriana has been reported widely from the New South Wales coast (Womersley, 1967; May *et al.*, 1970; May and Larkum, 1981). These records are here recognized as of *Z. diesingiana*.

Seasonality: sporangial plants collected in all months of the year.

Australian distribution: reported from Sydney to Coffs Harbour in New South Wales and Lord Howe Island (Allender and Kraft, 1983); also at Norfolk Island and on the New South Wales coast south to Green Cape; the most abundant dictyotalean alga on the central New South Wales coast (King and Farrant, 1987), at Lord Howe Island (Allender and Kraft, 1983) and in the Coffs Harbour region (A. Millar, *pers. comm.*), in both sheltered and open coast localities in eulittoral rock pools and to depths of 20m; abundance declines markedly with distance south and north of the central New South Wales region.

Selected specimens examined: New South Wales: Hastings Point, 19-v-1986, *Phillips*, MUCV 2561; Coffs Harbour, 1-2m, 8-x-1985, *Farrant*, UNSW 18618; Diamond Head, 0-1m, 10-x-1985, *P. and W. Farrant*, UNSW 18669; Fairlight, 1-2m, 26-xi-1985, *Farrant*, UNSW 18582; Fairlight, 5m, 29-iv-1986, *Farrant*, UNSW 18846; Kiama, July 1899, *Lucas*, NSW; Jervis Bay, LWM, 18-iii-1985, *King*, UNSW 17711; Broulee, 21-viii-1987, *D. May*, MUCV 2574; Malau Bay, 21-viii-1987, *D. May*, MUCV 2569; Barragga Point, LWM, 13-xi-1986, *Farrant*, UNSW 19360. Queensland: Noosa, 4-xii-1976, *King and Kertesz*, UNSW 15313.

COMPARISON WITH *ZONARIA* SPECIES IN ADJACENT REGIONS

Four species are found in southern Australia, *Zonaria angustata*, *Z. crenata*, *Z. spiralis* (J. Agardh) Papenfuss and *Z. turneriana* J. Agardh. *Zonaria spiralis* has a southern distribution from Rottnest Island, Western Australia, to Flinders, Victoria, and has characteristic spirally-twisted branches. *Zonaria turneriana* is found from Geraldton, Western Australia, to Port Phillip Heads, Victoria, Tasmania, and New Zealand. This species has mature fronds that are more or less linear, and 8-10 cells thick, but which are broader than those of *Z. angustata* (2-5[-8]mm). Only *Z. crenata* and *Z. diesingiana* occur in Queensland.

Homoeostrichus J. Agardh

Growth from a marginal row of apical cells. **Thalli** in transverse section having cells of medulla of uniform size and arranged in regular tiers, cells of the cortex mostly unpaired; sporangia with 4 aplanospores.

The genus *Homoeostrichus* was formerly placed within *Zonaria* (Papenfuss, 1944), but has been recently re-established by Womersley (1987). *Homoeostrichus* can be distinguished from *Zonaria* by sporangia with 4 aplanospores, as yet only observed in *H. sinclairii* and *H. olsenii* (*cf.* 8 in *Zonaria*), and by mostly unpaired cortical cells (which are mostly paired in *Zonaria*).

There are two species of *Homoeostrichus* in New South Wales, *H. olsenii* and *H. sinclairii*; both can be difficult to separate from *Zonaria diesingiana*.

KEY TO THE SPECIES OF *HOMOEOSTRICHUS* IN NEW SOUTH WALES

1. Thallus broadly fan-shaped, greyish, 5(-6) cells thick below apex ..... *H. olsenii*

1.* Thallus with cuneate (wedge-shaped) terminal segments, light brown, denuded below, 6 cells thick except thicker at 'midrib' ..... *H. sinclairii*

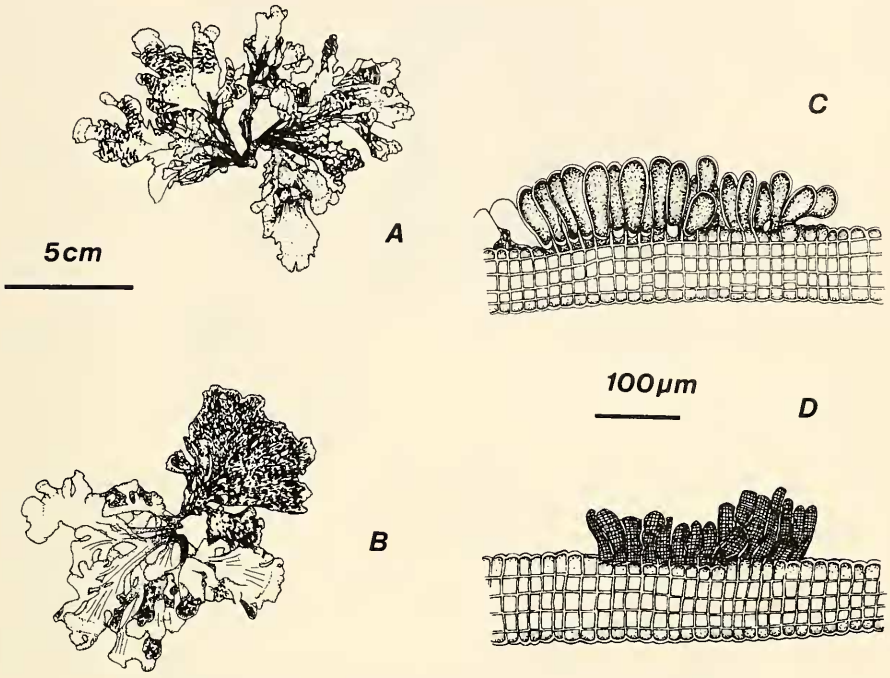


Fig. 21. Homoeostrichus olsenii: (**A**) habit of sporangial plant (UNSW 18242), (**B**) habit of male plant (UNSW 18243), (**C**) section of sporangial plant (UNSW 18216), (**D**) section of male plant (UNSW 18243).

Homoeostrichus olsenii Womersley, 1987:243.

Thalli 9-12cm long, a greyish colour; fronds 1-3(-6)cm wide (Fig. 21**A**,**B**), complanate, flabellate or irregular, with dense hairs covering most of the under surface; 5(-6) cells thick (Fig. 21**C**,**D**); sporangial sori (Fig. 21**C**) scattered across the frond in roughtly concentric rows; male gametangia in orange-brown sori without paraphyses (Fig. 21**D**).

Seasonality: sporangial plants collected in April, July, September, October, and November; male plants in April and July.

Australian distribution: south-eastern Australia, Nora Creina, South Australia, to Sydney Harbour (Womersley, 1987); in the present study from three relatively rough water localities in the Sydney region, to depths of 21m.

Selected specimens examined: New South Wales: Fairlight, 2-3m, 16-ix-1985, *Farrant*, UNSW 18293; Fairlight, 2-3m, 8-vii-1985, *Farrant*, UNSW 18216; Dobroyd, 8-iv-1979, *Farrant*, UNSW 18779; Bare I., 6m, 25-vii-1985, *Farrant*, UNSW 18242 and UNSW 18243; Bare I., 10m, 17-x-1985, *Farrant*, UNSW 18567; Boat Harbour, 21m, 21-iv-1975, *Harada* R2361, NSW.

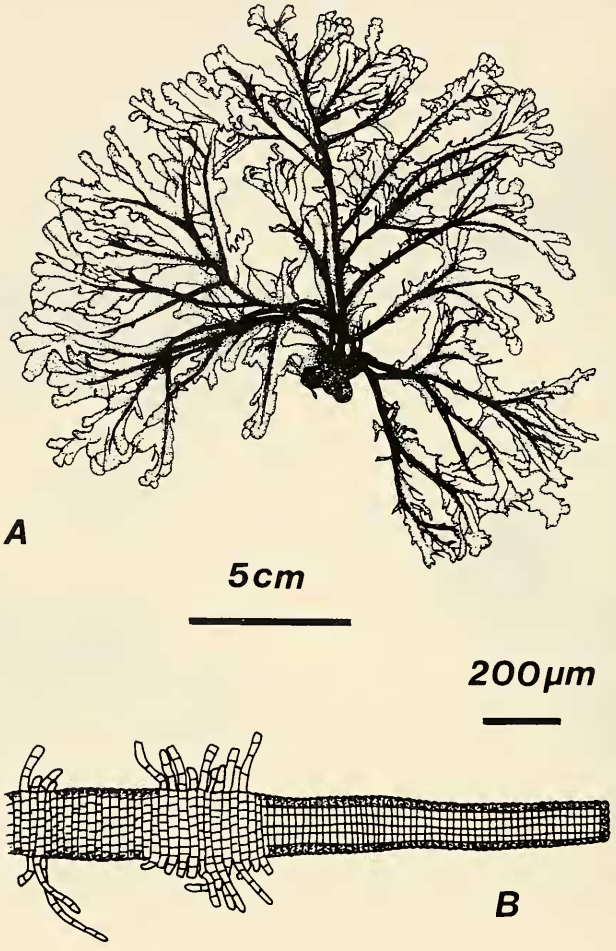


Fig. 22. Homoeostrichus sinclairii: (**A**) habit (UNSW 18020), (**B**) T.S. through frond 'midrib' (UNSW 18004).

Homoeostrichus sinclairii (Hooker and Harvey) J. Agardh, 1894:15; Womersley, 1987:242.

Zonaria sinclairii Hooker and Harvey, 1845:530.

Thalli 8-18cm long; fronds linear with cuneate terminal segments to about 1cm wide, narrowing below to a bare 'midrib' (Fig. 22**A**); hairs largely on 'midrib'; in transverse section generally 6 cells thick below the apex and expanded at the 'midrib' (Fig. 22**B**); sporangia with multicellular pedicels, amongst hairs.

Seasonality: collected throughout the year, with sporangial plants in all except the summer months; gametangial plants unknown for this species.

Australian distribution: southern and eastern Australia (Great Australian Bight to Newcastle) (Womersley, 1987), and as far north as Broughton Island, in relatively rough water localities and at depths greater than 2m.

Selected specimens examined: New South Wales: Broughton I., 2m, 28-iv-1985, *Farrant*, UNSW 18027; Norah Head, 19-iv-1978, *Kertesz*, UNSW 15308; Long Reef, 2-

vii-1975, *Harada* R4024, NSW; Dobroyd, 10m, 24-ix-1985, *Farrant*, UNSW 18535; Bare I., 5m, 6-iii-1986, *Farrant*, UNSW 18301; Plantation Point, 26-i-1974, *Larkum*, NSW.

COMPARISON WITH *HOMOEOSTRICHUS* SPECIES IN ADJACENT REGIONS

A third species, *Homoeostrichus canaliculatus* (J. Agardh) J. Agardh, is found in southern Australia but not in New South Wales. This species has linear fronds mostly 1-1.5mm wide and 6-7 cells thick (Womersley, 1987).

Stypopodium Kuetzing

Growth from a marginal row of apical cells. **Thalli** prostrate or erect, membranous; fronds in transverse section having cortical cells smaller than medullary cells and medullary cells not strictly tiered in transverse section; no sterile paraphyses associated with sporangia.

Stypopodium can easily be confused with *Taonia*. It differs from *Taonia* in having thick distal fronds, the fronds becoming 4 cells thick close to the apex (*Taonia* has thin distal fronds and becomes 4 cells thick at a distance from the apex, Fig. 23**A**); in *Stypopodium* there is an abrupt change in the size of cells from the cortex to the medulla with pigmented cortical cells much smaller (in *Taonia* there is no such abrupt change in cell size, Fig. 23**B**). Allender and Kraft (1983) also refer to the smoothly arching laciniae in most clumps of *Taonia* which are not seen in *S. australasica* (Zanardini) Allender and Kraft.

Stypopodium flabelliforme is the only species of the genus from the mainland New South Wales coast, although specimens exhibit some gradation towards both *S. australasicum* and *S. flabelliforme* var. *rabdoides* Allender and Kraft, both recorded for Lord Howe Island by Allender and Kraft (1983). Mainland New South Wales specimens are variable in habit (erect with single holdfast to decumbent with overlapping blades), frond shape (flabellate to lobed), and colour (light brown, iridescent, or with slightly darker longitudinal bands).

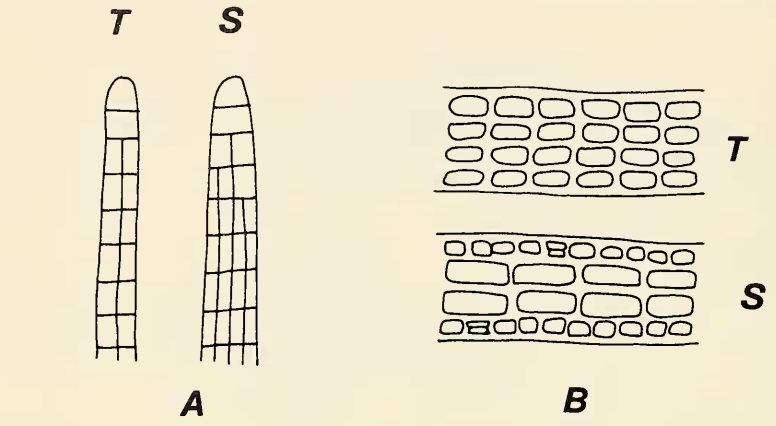
Stypopodium flabelliforme Weber-van Bosse, 1913:176. Allender and Kraft, 1983: 96.

Thalli 4-8cm long, usually decumbent although larger plants erect, brown, often iridescent (blue-green) with dark longitudinal bands not obvious on the brown dried thalli; fronds 2-9cm wide, flabellate and sometimes divided into irregular lobes (Fig. 24**A**,**B**); regular concentric hair lines sometimes present, especially on larger flabellate plants (Fig. 24**A**); fronds in section having a medulla 4-6 cells thick in the lower parts (Fig. 24**C**,**D**); sporangia densely scattered all over the fronds (except for conspicuous sterile bands next to the hair lines), or in patches.

Seasonality: collected in most months, sporangial plants in February, April and October; no gametangial plants.

Australian distribution: Lord Howe Island and the southern Great Barrier Reef (Allender and Kraft, 1983); Allender and Kraft (1983) were the first to record the species for the Australian mainland coast (Coffs Harbour, New South Wales, and Heron I., Queensland); in this study collected south to Jervis Bay, from the upper sublittoral to depths of 20m, mostly on open coasts.

Selected specimens examined: New South Wales: NW Solitary I., 10-16m, 6-x-1985, *Farrant*, UNSW 18603; Seal Rocks, 0-2m, 10-x-1985, *P. and W. Farrant*, UNSW 18679; Clovelly, 1-3m, 16-iv-1985, *Farrant*, UNSW 17781; Jervis Bay, 15m, 14-iv-1984, *Farrant*, UNSW 16201; Plantation Point, 30-vii-1973, *V. May*, NSW; Malau Bay, 21-viii-1987, *D. May*, MUCV 2570.



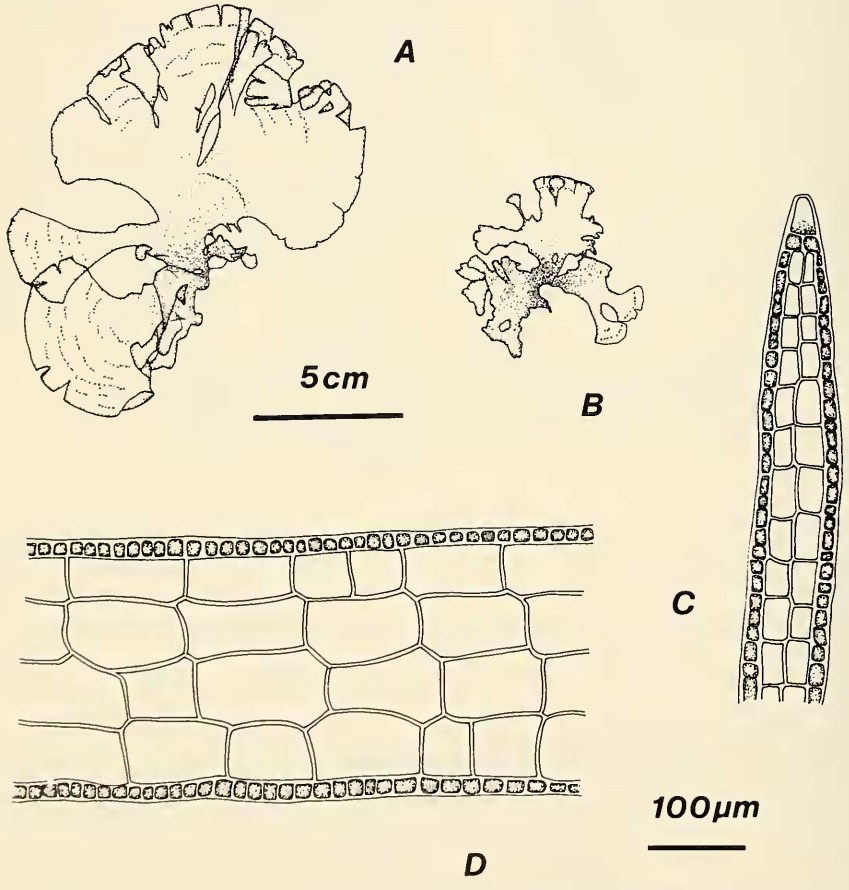


Fig. 23 (above). Diagrams showing the differences between *Taonia* (T) and *Stypopodium* (S): (**A**) L.S. apex, (**B**) T.S. lower part of frond.

Fig. 24 (below). *Stypopodium flabelliforme:* (**A**) habit of broad flabellate plant (UNSW 18601), (**B**) habit of smaller more prostrate plant (UNSW 17770), (**C**) L.S. through apex (UNSW 18043), (**D**) L.S. through frond (UNSW 18014).

COMPARISON WITH *STYPOPODIUM* SPECIES IN ADJACENT REGIONS

Two other taxa of *Stypopodium* are found at Lord Howe Island, *S. flabelliforme* var. *rabdoides* and *S. australasicum* (Allender and Kraft, 1983), and a further two have been recorded for northern Australia, *S. zonale* (Lamouroux) Papenfuss and *S. lobatum* Kuetzing (Lewis, 1985). The genus is not recorded in southern Australia.

Taonia J. Agardh

Growth from a marginal row of apical cells. **Thalli** erect, membranous; fronds flabellate, often deeply dissected; surface cells similar in size to medullary cells, distal part of frond thin, two cells thick, thicker in lower parts; sori scattered on frond in more or less concentric zones.

Taonia can be easily confused with *Stypopodium* (Fig. 23**A**,**B**) (see notes under that species). There is only one species of *Taonia* in New South Wales, *T. australasica*.

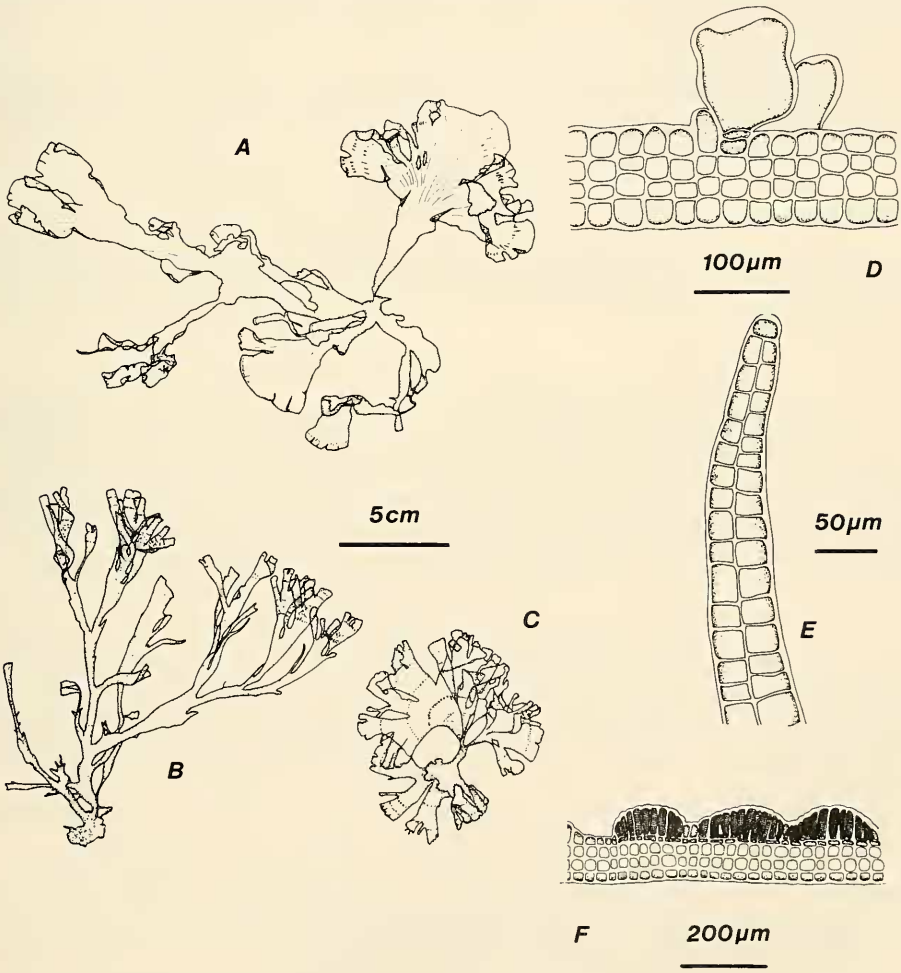


Fig. 25. Taonia australasica: (**A**) habit of large, broad plant (UNSW 18070), (**B**) habit of narrow fronded plant (UNSW 17634), (**C**) habit of broad plant (UNSW 17774), (**D**) T.S. through sporangium (UNSW 17634), (**E**) L.S. through apex (UNSW 18066), (**F**) T.S. through male gametangial sorus (UNSW 18234).

Taonia australasica J. Agardh, 1894:30. Allender and Kraft, 1983:91; Womersley, 1987:238.

Thalli 4-19cm long, tan-olive in colour at the top, dark brown at the base; fronds 0.5-17cm wide, flabellate (Fig. 25**A-C**), in transverse section cells similar in size throughout (Fig. 25**D**), thin, remaining 2 cells thick for some distance below the apex (Fig. 25**E**); sporangia borne on two stalk cells at maturity, sessile or partially embedded in the thallus (Fig. 25**D**); antheridia in indusiate sori on male plants (Fig. 25**F**).

Seasonality: collected in all months except December, but seasonally abundant with marked decrease in abundance and biomass in summer (King and Farrant, 1987); sporangial plants collected in all months of the year except October and December; the single male gametangial plant collected in July the first record of sexual reproduction for this species.

Australian distribution: south-eastern Australia, from Kangaroo Island, South Australia, to Coffs Harbour, New South Wales (Womersley, 1987), and Lord Howe Island (Allender and Kraft, 1983); found in the sublittoral below 2m depth at both open coast and estuarine localities (Sydney Harbour).

Selected specimens examined: New South Wales: Broughton I., 2m, 28-iv-1985, *Farrant*, UNSW 18024; Harbord, 1-2m, 16-ii-1985, *Farrant*, UNSW 17610; Fairlight, 1-2m, 16-iv-1986, *Farrant*, UNSW 18358; Mrs Macquarie's Point, 2m, 27-vi-1985, *Farrant and Puttock*, UNSW 18211.

COMPARISON WITH *TAONIA* SPECIES IN ADJACENT REGIONS

Taonia australasica is the only species of *Taonia* found in Australia. It is found in the regions adjacent to New South Wales, at Lord Howe Island, in Queensland and in southern Australia.

Conclusions

The algae of the New South Wales coastline have been much less studied than those on adjacent shores, especially those to the south. The Dictyotales are well represented in the flora with 22 species in 13 genera, and since they are abundant during most seasons especially in the upper sublittoral (King and Farrant, 1987) they are frequently referred to in ecological accounts. The present treatment has clarified the species encounted in New South Wales and provides keys and descriptions for their ready identification.

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References

Agardh, J. G., 1841. — In historiam algarum symbolae. *Linnaea* 15: 1-50.
——, 1848., — *Species, Genera et Ordines Algarum*. Vol. 1. Lund: Gleerup.
——, 1872. — Till algernes systematik. *Acta Univ. Lund.* 9: 1-71.
——, 1882. — Till algernes systematik. *Acta Univ. Lund.* 17: 1-136, pls 1-3.
——, 1894. — Analecta Algologica. Cont. I. *Acta Univ. Lund.* 29: 1-144, pl. 1.
Allender, B. M., 1980. — *Dictyotopsis propagulifera* (Phaeophyta) — an algal enigma. *Phycologia* 19: 234-236.
——, and Kraft, G. T., 1983. — The marine algae of Lord Howe Island (New South Wales): the Dictyotales and Cutleriales (Phaeophyta). *Brunonia* 6: 73-130.

ARESCHOUG, J. E., 1854. — Phyceae novae et minus cognitae in maribus extraeuropaeis collectae. *Acta Reg. Soc. Sci. Upsala, Ser III* 1: 329-372.

BOERGESEN, F., 1935. — A list of marine algae from Bombay. *K. Dan. Vidensk. Selsk. Biol. Meddr* 12: 1-64, pls. 1-10.

BOLD, H. C., and WYNNE, M. J., 1985. — *Introduction to the Algae. Structure and Reproduction.* 2nd Edition. Englewood Cliff, New Jersey: Prentice-Hall Inc.

BOROWITKZA, M. A., KING, R. J., and LARKUM, A. W. D., 1982. — Field guide to the marine plants of New South Wales. Chlorophyta, Phaeophyta, and Seagrasses. (Privately publ., Sydney). 70 pp.

BORY DE SAINT-VINCENT, J. B., 1827. — Padine. *Dict. Class. Hist. Nat.* 12: 589-91. Paris.

CRIBB, A. B., 1954. — Records of marine algae from south-eastern Queensland, I. *Pap. Dep. Bot. Univ. Qd* 3: 15-37.

EARLE, S. A., 1969. — Phaeophyta of the eastern Gulf of Mexico. *Phycologia* 7: 71-254.

EDELSTEIN, T., and WOMERSLEY, H. B. S., 1975. — The thallus and spore development of *Lobospira bicuspidata* Areschoug (Dictyotales): Phaeophyta. *Trans Roy. Soc. S. Aust.* 99: 149-156.

GEPP, A., and GEPP, E. S., 1906. — Some marine algae from New South Wales. *J. Bot.* 44: 249-261.

GREVILLE, R. K., 1830. — *Algae Britannicae.* Edinburgh: MacLachlan & Stewart.

HARVEY, W. H., 1860. — *Phycologia Australica.* Vol. III., London: Reeve.

HAUCK, F., 1887. — Über einige von J. M. Hildebrandt in Rothen Meere und Indischen Ocean gesammelte Algen. *Hedwigia* 2: 41-45.

HAUPT, A. W., 1932. — Structure and development of *Zonaria farlowii. Am. J. Bot.* 19: 239-254, pls XIX-XXII.

HOOKER, J. D., and HARVEY, W. H., 1845. — Algae Novae Zelandiae. *Lond. J. Bot.* 4: 521-551.

KING, R. J., and FARRANT, P. A., 1987. — The phenology of the Dictyotales (Phaeophyceae) at a sheltered locality in Sydney Harbour, New South Wales, Australia. *Bot. Marina* 30: 341-350.

LAMOUROUX, J. V. F., 1809. — Observations sur la Physiologie des Algues marines, et description de cinq nouveaux genres de cette famille. *Nouv. Bull. Sci. Soc. Philom. Paris* 1: 330-333, pl. 6.

LEVRING, T., 1940. — Die Phaeophyceengattungen *Chlanodiphora*, *Distromium*, und *Syringoderma. K. fysiogr. sallsk. Lund. Forh.* 10: 1-11.

LEWIS, J. A., 1985. — Checklist and bibliography of benthic marine macroalgae recorded from northern Australia. II. Phaeophyta. Department of Defence Materials Research Laboratories, Victoria. Report MRL-R-962, 40 pp.

LINDAUER, V. W., CHAPMAN, V. J., and AIKEN, M., 1961. — The marine algae of New Zealand. II: Phaeophyceae. *Nova Hedwigia* 3: 129-350.

LUCAS, A. H. S., 1909. — Revised list of the Fucoideae and Florideae of Australia. *Proc. Linn. Soc. N.S.W.* 34: 9-61.

——, 1913. — Notes on Australian marine algae. i. Fucoideae. *Proc. Linn. Soc. N.S.W.* 38: 49-60.

——, 1914. — Marine algae. *British Association for the Advancement of Science. Handbook for N.S.W.*: 459-463. Sydney: Edward Lee & Co.

——, 1935. — The marine algae of Lord Howe Island. *Proc. Linn. Soc. N.S.W.* 60: 194-232.

MAY, V., 1939. — A key to the marine algae of New South Wales — Part II. Melanophyceae (Phaeophyceae). *Proc. Linn. Soc. N.S.W.* 64: 191-215.

——, BENNETT, I., and THOMPSON, T. E., 1970. — Herbivore-algae relationships on a coastal rock platform (Cape Banks, N.S.W.). *Oecologia (Berl.)* 6: 1-14.

——, COLLINS, A. J., and COLLETT, L. C., 1978. — A comparative study of epiphytic algal communities on two common genera of sea-grasses in eastern Australia. *Aust. J. Ecol.* 3: 91-104.

——, and LARKUM, A. W. D., 1981. — A subtidal transect in Jervis Bay, New South Wales. *Aust. J. Ecol.* 6: 439-457.

NGAN, Y., and PRICE, I. R., 1979. — The intertidal algae of the mainland coast in the vicinity of Townsville, Queensland, tropical Australia. *Atoll Res. Bull.* 237: 1-29.

——, and ——, 1980. — Seasonal growth and reproduction of intertidal algae in the Townsville region (Queensland, Australia). *Aq. Bot.* 9: 117-134.

PAPENFUSS, G. F., 1943. — Notes on algal nomenclature. II. *Gymnosorus* J. Agardh. *Am. J. Bot.* 30: 463-468.

——, 1944. — Notes on algal nomenclature. III. Miscellaneous species of Chlorophyceae, Phaeophyceae and Rhodophyceae. *Farlowia* 1: 337-346.

——, 1952. — Notes on South African marine algae. III. *J. S. Afr. Bot.* 17: 167-188.

READER'S DIGEST, 1977. — *Atlas of Australia.* Sydney: Reader's Digest Services Pty Ltd.

SONDER, W., 1871. — Die Algen des tropischen Australiens. *Abh. naturw. Ver. Hamburg* 5: 33-74, plates 1-6.

SONDER, O. G., 1880. — I. Algae Australianae hactenus cognitae. In: *Fragmenta phytographiae Australiae*, Suppl. ad. Vol. II (F. Mueller): 1-42. Melbourne.

WEBER-VAN BOSSE, A., 1913. — Liste des algues du Siboga. I. Myxophyceae, Chlorophyceae, Phaeophyceae. *Siboga Exped. Monogr.* 59a: 1-186.